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Recirculated Draft

Substitute Environmental Document in Support of
Potential Changes to the Water Quality Control Plan
for the San Francisco Bay–Sacramento San Joaquin Delta Estuary

San Joaquin River Flows and Southern Delta Water Quality

State Water Resources Control Board | California Environmental Protection Agency

RECIRCULATED DRAFT

SUBSTITUTE ENVIRONMENTAL DOCUMENT IN SUPPORT OF POTENTIAL CHANGES TO THE WATER QUALITY CONTROL PLAN FOR THE SAN FRANCISCO BAY-SACRAMENTO/SAN JOAQUIN DELTA ESTUARY: SAN JOAQUIN RIVER FLOWS AND SOUTHERN DELTA WATER QUALITY

STATE CLEARINGHOUSE NO. 2012122071

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Acronyms and Abbreviations

2006 Bay-Delta Plan	2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary
AB	Assembly Bill
ACEC	areas of critical environmental concern
AF	acre-feet
AF/day	acre-feet per day
AF/y	acre-feet per year
AFRP	Anadromous Fish Restoration Program
AFSP	Anadromous Fish Screen Program
AGR	agricultural supply
AIRFA	American Indian Religious Freedom Act
AR/NHI	American Rivers and Natural Heritage Institute
ARB	California Air Resources Board
ARPA	Archeological Resources Protection Act of 1979
ARTDA	Amended and Restated Treatment and Delivery Agreement
ASR	aquifer storage and recovery
AWMP	agricultural water management plan
BAAQMD	Bay Area Air Quality Management District
BANC	Balancing Authority of Northern California
Basin Plan	Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
BAU	business as usual
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin Delta
BCWD	Ballico-Cortez Water District
BKD	bacterial kidney disease
BLM	Bureau of Land Management
BMPs	best management practices
BO	biological opinion
BPS	best performance standards
CAA	Clean Air Act
CAD	Cowell Agreement Diverters
CAISO	California Independent System Operator
Cal. Code Regs	California Code of Regulations
Cal-IPC	California Invasive Plant Council
CalISO	California Independent System Operator
CAO	Cooperative Operating Agreement
CAPCOA	California Air Pollution Control Officers Association
CAS	Climate Adaptation Strategy
CASGEM	California Statewide Groundwater Elevation Monitoring
CCCDCD	Contra Costa County Department of Conservation and Development
CCF	Clifton Court Forebay
CCID	Central California Irrigation District

CCP	comprehensive conservation plan
CCRs	consumer confidence reports
CCSF	City and County of San Francisco
CCWD	Contra Costa Water District
CDCR	California Department of Corrections and Rehabilitation's
CDFA	California Department of Food and Agriculture
CDFEW	California Department of Fish and Wildlife
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CDWA	Central Delta Water Agency
CEC	California Energy Commission
CEHTP	California Environmental Health Tracking Program
Central Valley Water Board	Central Valley Regional Water Quality Control Board
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CH4	methane
cm	centimeter
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO2	carbon dioxide
CO2e	carbon dioxide equivalent
COA	Coordinated Operations Agreement
Contra Costa WD	Contra Costa Water District
CPUC	California Public Utilities Commission
CRHR	California Register of Historical Resources
CSD	community service districts
CSJWCD	Central San Joaquin Water Conservation District
CUAW	consumptive use of applied water
CVFPB	California Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWA	Clean Water Act
C-WIN/CSPA	California Sportfishing Protection Alliance
CWP	California Water Plan
DACs	disadvantaged communities
DAU	detailed analysis unit
DBCP	dibromochloropropane
DBW	California Department of Boating and Waterways
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DDW	Division of Drinking Water
Delta	Sacramento–San Joaquin Delta
Delta RMP	Delta Regional Monitoring Program

DMC	Delta-Mendota Canal
DO	dissolved oxygen
DOC	California Department of Conservation
DOI	U.S. Department of the Interior
DPH	California Department of Public Health
DPRA	Don Pedro Recreation Agency
DPS	Distinct Population Segment
DROPS	Drought Response Outreach Program for Schools
dS/m	deciSiemens per meter
DSG	Davis Delta Solutions Group
DSM2	Delta Simulation Model 2
DSOD	Division of Safety of Dams
DWR	Department of Water Resources
DWSC	Deep Water Ship Channel
DWSP	Delta Water Supply Project
DWSRF	Drinking Water State Revolving Fund
DWWSP	Davis-Woodland Water Supply Project
E/I	export/inflow
EC	electrical conductivity
EDU	electrical distribution utilities
EIR	Environmental Impact Report
EIS/EIR	Environmental Impact Statement/ Environmental Impact Report
ENR	Engineering News-Record
EO	executive order
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EWA	environmental water account
EWMPs	efficient water management practices
Farmland	Farmland of Statewide Importance
FERC	Federal Energy Regulatory Commission
FMMP	Farmland Mapping and Monitoring Program
FPA	Federal Power Act
ft	feet
ft/s	feet/second
ft/y	feet per year
FY	fiscal year
GAMA	Groundwater Ambient Monitoring and Assessment Program
GFDL	Geophysical Fluid Dynamic Lab
GHG	greenhouse gas
GSAs	groundwater sustainability agencies
GSPs	groundwater sustainability plans
GWh	gigawatt hours
GWMP	groundwater management plan
GWP	global warming potential
HCP	habitat conservation plan
HEC	Hydrologic Engineering Center

HFCs	hydrofluorocarbons
HORB	Head of Old River Barrier
HPMP	historic properties management plan
HSC	habitat suitability criteria
ICW	Inspection of Completed Works
IEP	Interagency Ecological Program
IEUA	Inland Empire Utilities Agency
IFIM	Instream Flow Incremental Methodology
IHN	infectious hematopoietic necrosis
IMPLAN	Impact Analysis for Planning model
IND	Industrial service supply
IOUs	investor-owned utilities
IPCC	Intergovernmental Panel on Climate Change
IPO	interim plan of operations
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Program
IS/MND	initial study/mitigated negative declaration
IS0	Independent System Operators
ISAA	Irrigation Service Abandonment Agreement
JSA	Joint Settlement Agreement
km	kilometers
KMZ	Klamath Management Zone
kV	kilovolt
kWh	kilowatt hour
LACSD	Los Angeles County Sanitation Districts
LAFCo	Local Agency Formation Commission
LCRs	local capacity requirements
LDPCSD	Lake Don Pedro Community Service District
LESA	Land Evaluation and Site Assessment model
LIDAR	Light Detection and Ranging
LLNL	Lawrence Livermore National Laboratory
LSJR	Lower San Joaquin River
No Project Alternative	LSJR Alternative 1 and SDWQ Alternative 1
LSZ	low salinity zone
LTE	long-term emergency ratings
m	meters
M&I	municipal and industrial
MAF	million acre-feet
Manteca	City of Manteca
MCL	maximum contaminant levels
Merced ID	Merced Irrigation District
mg/L	milligrams per liter
Mgd	million gallons per day
MHW	mean high water
MID	Modesto Irrigation District
MLW	mean low water

mm	Millimeters
mmhos/cm	millimhos per centimeter
MOA	memorandum of agreement
MRWTP	Modesto Regional Wastewater Treatment Plant
MSL	mean sea level
MT	metric tons
MUN	municipal and domestic water supply
MW	megawatts
N_2O	nitrous oxide
NAGPRA	Native American Graves Protection and Repatriation Act
NERC	North American Electric Reliability Corporation
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMFS BO	National Marine Fisheries Service's Biological Opinion
NOP	notice of preparation
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSJWCD	Northern San Joaquin Water Conservation District
NWIP	Noxious Weed Information Project
NWS	National Weather Service
O&M	operations and maintenance
OAG	Office of the Attorney General
OID	Oakdale Irrigation District
OAL	Office of Administrative Law
OCAP	Operational Criteria and Plan
OMR	Old and Middle River
OPR	Office of Planning and Research
PCM	Parallel Climate Model
PDK	proliferative kidney disease
PFCs	perfluorocarbons
PFMC	Pacific Fisheries Management Commission
PG&E	Pacific Gas and Electric Company
POE	point-of-entry
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
POU	point-of-use
ppm	parts per million
PPP	pollution prevention plan
ppt	parts per thousand
PRO	industrial process supply
PSD	Prevention of Significant Deterioration
Pub. Resources Code	California Public Resources Code
RA	resource adequacy
Recovery Plan	Recovery Plan for Upland Species of California
Recovery Program	Colorado Endangered Fish Recovery Program
Regional Water Boards	Regional Water Quality Control Boards

Reporting Rule	Greenhouse Gas Reporting Rule
R-GPCD	residential gallons per capita per day
RM	river miles
RMP	resource management plan
RO	reverse osmosis
ROD	record of decision
RPA	Reasonable and Prudent Action
RPS	renewable portfolio standard
RTMP	real-time water quality management program
RVDs	recreation visitor days
SalSim	Salmon Simulation model
San Francisco PUC	San Francisco Public Utility Commission
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SCAQMD	South Coast Air Quality Management District
Scoping Plan	The Climate Change Scoping Plan
SDIP EIS/EIR	South Delta Improvement Program Environmental Impact Statement/Environmental Impact Report
SDWA	South Delta Water Agency
SED	substitute environmental document
SEWD	Stockton East Water District
SF_6	sulfur hexafluoride
SFPUC	San Francisco Public Utilities Commission
SGMA	Sustainable Groundwater Management Act
Sierra ROD	Sierra Resource Management Record of Decision
SJCFCWD	San Joaquin County Flood Control and Water Conservation District
SJR	San Joaquin River
SJRA	San Joaquin River Agreement
SJRGA	San Joaquin River Group Authority
SJRMEP	San Joaquin River Monitoring and Evaluation Program
SJRRP	San Joaquin River Restoration Program
SJVAPCD	San Joaquin Valley Air Pollution Control District
SL	standard length
SMUD	Sacramento Municipal Utility District
SNR	Sierra Nevada Region
SONAR	Sound Navigation and Ranging
SR	State Route
SRA	State Recreation Area
SSJID	South San Joaquin Irrigation District
State Water Board	State Water Resources Control Board
STM Working Group	Stanislaus, Tuolumne, and Merced Working Group
Stockton	City of Stockton
SWAP	Statewide Agricultural Production
SWP	State Water Project
TAF	thousand acre-feet

TAF/y	TAF per year
TBI/NRDC	The Bay Institute and Natural Resources Defense Council
TBP	Temporary Barrier Program
TDS	total dissolved solids
TID	Turlock Irrigation District
TMDL	total maximum daily load
Tracy	City of Tracy
TUCP	Temporary Urgency Change Petition
Upper SJR	Upper San Joaquin River
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USC	United States Code
USDA	U.S. Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWMP	urban water management plan
UWMPA	California Urban Water Management Planning Act
UWMPs	urban water management plans
VAMP	Vernalis Adaptive Management Plan
VOCs	volatile organic compounds
WAP	Water Acquisition Program
WDR	waste discharge requirements
WECC	Western Electricity Coordinating Council
WID	Woodbridge Irrigation District
Williamson Act	California Land Conservation Act of 1965
WMA	Weed Management Area
WQCP	water quality control plans
WQO	Water Quality Order
WSCP	Water Shortage Contingency Plan
WSE	Water Supply Effects model
WSIP	Water System Improvement Program
WTP	willingness to pay
WUA	weighted usable area
WWTP	wastewater treatment plant
WY	water year
µmhos/cm	micromhos per centimeter

Chapter 1
Introduction

This chapter provides a brief description of the project and plan area, as well as contextual background for this recirculated substitute environmental document (SED). It also describes the State Water Quality Control Board's (State Water Board's) authorities and provides a timeline of State Water Board past and proposed actions related to the plan amendments.

1.1 Project Description

The State Water Board is considering amendments to the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan). The 2006 Bay-Delta Plan designates beneficial uses of water within the Bay-Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives.

The project (plan amendments) would establish the following updates to the 2006 Bay-Delta Plan.

- New flow objectives on the Lower San Joaquin River (LSJR)[1] and its three eastside tributaries[2] for the protection of fish and wildlife beneficial uses.
- Revised water quality objectives for the protection of agricultural beneficial uses in the southern Delta.
- A program of implementation to achieve these objectives.
- Monitoring and special studies necessary to fill information needs and determine the effectiveness of, and compliance with, the new objectives.

The new LSJR flow objectives and revised southern Delta water quality (SDWQ) objective and associated program of implementation would replace the existing San Joaquin River (SJR) flow and southern Delta salinity objectives and associated program of implementation in the 2006 Bay-Delta Plan.

1.2 Plan Area

The plan amendments involve changes in flow requirements in the SJR Basin and changes in water quality objectives for the southern Delta (Figure ES-1). The plan area encompasses the areas where the plan amendments apply to protect beneficial uses of water. For example, the LSJR flow objectives would require flows below the rim dams on the Stanislaus, Tuolumne, and Merced Rivers, and the mainstem of the LSJR between the confluence of the Merced River to Vernalis to protect fish and wildlife beneficial uses in those reaches. Thus, these plan amendments could directly affect

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[1] The LSJR is that portion of the San Joaquin River between its confluence with the Merced River and downstream to Vernalis, and its three eastside tributaries—the Stanislaus, Tuolumne, and Merced Rivers.

[2] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

portions of the SJR Basin and Delta that drain into, divert water from, or otherwise obtain beneficial use (e.g., surface water supplies) from the following water bodies. These portions of the SJR Basin and Delta are referred to as the *plan area* throughout this SED (Figure ES-2).

- Stanislaus River Watershed, from and including New Melones Reservoir to the confluence of the LSJR.
- Tuolumne River Watershed, from and including New Don Pedro Reservoir to the confluence of the LSJR.
- Merced River Watershed, from and including Lake McClure to the confluence with the LSJR.
- Mainstem of the LSJR, between its confluence with the Merced River downstream to Vernalis.
- Areas that receive a portion of their water supply from, and that are contiguous with, the above areas.
- The southern Delta, including the SJR from Vernalis to Brandt Bridge, Middle River from Old River to Victoria Canal, and Old River/Grant Line Canal from the Head of Old River to West Canal.

In addition to implementing the plan amendments in the plan area, the State Water Board will evaluate, in a subsequent water rights proceeding, whether to impose responsibility on surface water users who divert surface water from the Stanislaus, Tuolumne, and Merced River Watersheds above the major dams. The plan amendments also have the potential to affect areas within the watersheds that receive a portion of their water supply from these areas. These areas are referred to as the *extended plan area* throughout this SED and are listed below (Figure ES-2).

- Stanislaus River Watershed upstream of New Melones Reservoir.
- Tuolumne River Watershed upstream of New Don Pedro Reservoir.
- Merced River Watershed upstream of Lake McClure.

Finally, the plan amendments also have the potential to affect areas outside of the plan area or extended plan area that obtain beneficial use of water from the Stanislaus, Tuolumne, and Merced Rivers, and the LSJR downstream of the Merced River, but are not contiguous with the plan area or extended plan area. These areas are included in the areas of potential effects for some of the resources evaluated throughout this SED and are listed below.

- City and County of San Francisco (CCSF).
- Any other area served by water delivered from the plan area or extended plan area not otherwise listed above.

1.3 Background

This document is a recirculated SED. On December 31, 2012, the State Water Board released a draft SED (2012 Draft SED) for the review and update of the SJR flow and southern Delta salinity objectives and associated program of implementation. After holding a public workshop and receiving public comments on the 2012 Draft SED in 2013, the State Water Board decided to recirculate the document. This SED considers comments received on the 2012 Draft SED, as summarized in Appendix M, *Summary of Public Comment on the 2012 Draft SED,* and provides updated information and additional analyses on certain subjects, as described in the *Executive Summary* and Chapter 4, *Introduction to the Analysis*.

The State Water Board is currently conducting a phased evaluation of the 2006 Bay-Delta Plan. Phase I consists of a review and update of the current SJR flow and southern Delta salinity objectives and associated program of implementation. Phase II consists of review and potential modification to other parts of the 2006 Bay-Delta Plan, including Delta outflows, State Water Project (SWP) and Central Valley Project (CVP) export restrictions, and other requirements in the Bay-Delta to protect fish and wildlife beneficial uses. Phases I and II are independent of each other, addressing different water quality objectives and associated programs of implementation. In Phase III, the State Water Board will conduct proceedings to assign responsibility for actions to implement the water quality objectives established in Phase I and Phase II, including changes to water rights or other implementation actions.

When proposing to undertake or approve a discretionary project, state agencies must comply with the procedural and substantive requirements of the California Environmental Quality Act (CEQA).[3] (Pub. Resources Code, § 21000 et seq.) CEQA applies to discretionary projects that may cause a direct or indirect physical change in the environment. The State Water Board is the lead agency under CEQA. This SED was prepared in compliance with CEQA and other laws to analyze the potential environmental impacts of adopting and implementing the proposed amendments to the Bay-Delta Plan associated with Phase I. Environmental impacts associated with Phase II will be evaluated in a separate environmental document. Adoption of the Bay-Delta Plan itself will not result in physical changes in the environment. Rather, it is through the implementation of the objectives in the Bay-Delta Plan that physical changes in the environment potentially may occur. Because the Bay-Delta Plan does not approve any particular projects, the assessment of the potential environmental impacts associated with amendments to the Bay-Delta Plan are necessarily conducted at a programmatic level. Specific actions to implement the water quality objectives in the Bay-Delta Plan will be assessed at a project-level basis in compliance with CEQA. The State Water Board anticipates preparing an environmental impact report (EIR) to evaluate environmental effects of assigning responsibility to implement the water quality objectives, such as in a water rights proceeding to implement the amendments to the 2006 Bay-Delta Plan (Phase I and Phase II).

In addition to other legal requirements, the State Water Board must comply with the requirements of CEQA when adopting water quality control plans (WQCP). The purpose of this SED, in part, is to provide an environmental analysis of the proposed amendments to the Bay-Delta Plan and the reasonably foreseeable methods of compliance with the amendments, as well as consideration of other factors. CEQA authorizes the Secretary of the Resources Agency to certify a regulatory program of a State agency as exempt from the requirements for preparing EIRs, negative declarations, and initial studies if certain conditions are met. (Pub. Resources Code, § 21080.5.) The State Water Board's water quality control planning program is a certified regulatory program and thus, a SED may be prepared in lieu of an EIR. (*Ibid*.; Cal. Code Regs., tit. 14, § 15251, subd. (g).)

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[3] CEQA's basic purposes are to: (1) inform the decision makers and public about the potential significant environmental effects of a proposed project; (2) identify ways that environmental damage may be avoided or reduced; (3) prevent significant, avoidable damage to the environment by requiring changes in projects through the use of alternative or mitigation measures when feasible; and (4) disclose to the public why an agency approved a project in the manner the agency chose if significant effects are involved. (Cal. Code Regs., tit. 14, § 15002, subd. (a).) To fulfill these functions, a CEQA review need not be exhaustive, and CEQA documents need not be perfect. The CEQA documents should be adequate, complete, and represent a good faith effort at full disclosure. (*Id*., § 15151.)

This SED fulfills the requirements of CEQA and the State Water Board's CEQA regulations (Cal. Code Regs., tit. 23, § 3775 et seq.) to analyze the environmental effects of the proposed regulatory activity, as well as requirements of the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) and other applicable requirements as described in Section 1.4, *State Water Board Authorities*. This SED will inform the State Water Board's consideration of the potential amendments to the 2006 Bay-Delta Plan described above.[4]

1.4 State Water Board Authorities

The State Water Board was formed in 1967 when the State Water Rights Board and the State Water Quality Control Board were merged by the legislature, based on the principle that water rights and water quality are interrelated and should be regulated in an integrated manner. The State Water Board is composed of five full-time appointees of the governor. The State Water Board allocates rights to the use of surface water, protects water quality by setting statewide policy, regulates public drinking water systems and, in coordination with the nine regional water quality control boards (Regional Water Boards), takes actions to ensure the highest reasonable quality for waters of the state through administration of the Porter-Cologne Act and portions of the federal Clean Water Act (CWA).

1.4.1 Porter-Cologne Act

The Porter-Cologne Act is the principal water quality control law for California. It establishes a comprehensive program to protect surface and groundwater quality and the beneficial uses of water in the state. Under the Porter-Cologne Act, the state is divided into nine regions, and a Regional Water Board has primary responsibility for protecting water quality within each region. The State Water Board oversees the Regional Water Boards' implementation of the Porter-Cologne Act. Together with the Regional Water Boards, the State Water Board implements the federal Clean Water Act in California. Section 303 of the Clean Water Act (33 U.S.C., § 1313) provides for the adoption of water quality standards by the states.

The Regional Water Boards have primary responsibility for the formulation and adoption of water quality control plans for their respective regions, subject to the State Water Board's and United States Environmental Protection Agency (USEPA) approval, as appropriate. (Wat. Code, § 13240 et seq.) The State Water Board may also adopt water quality control plans, which will supersede regional water quality control plans for the same waters to the extent of any conflict. (*Id*., § 13170.) For a specified area, the water quality control plans designate the beneficial uses of waters that are to be protected, water quality objectives for the reasonable protection of the beneficial uses or the prevention of nuisance, and a program of implementation to achieve the water quality objectives. (*Id*., §§ 13241, 13050, subds. (h), (j).) The beneficial uses together with the water quality objectives that are contained in the water quality control plans, and applicable federal anti-degradation requirements, constitute California's water quality standards for purposes of the federal CWA. Water quality objectives usually are implemented through water quality actions, such as waste discharge requirements, or in the case of flow-related objectives, as conditions of water right permits or licenses or water quality certifications.

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[4] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

WQCPs are periodically reviewed and amended to protect water quality. After a WQCP is adopted, the Water Code and the CWA require, respectively, a periodic and a triennial review of water quality control plans or water quality standards under Water Code Section 13240 and under Section 303 subdivision (c)(1) of the CWA. (33 U.S.C., § 1313, subd. (c)(1).) As explained herein, compliance with CEQA and the preparation of environmental documentation is required as part of the WQCP amendment process.

1.4.2 Water Rights

The State Water Board exercises adjudicatory and regulatory water quality and water rights functions in California. All water in California belongs to the people of the State. Although water cannot be privately owned, the right to use water can be acquired pursuant to statutory and common law. The State Water Board's water rights authority has been the principal authority used to implement the Bay-Delta Plan in the past because the flow and salinity objectives have been implemented through flow measures that have required changes in water rights. The State Water Board has authority to amend an existing water right permit or license under various authorities, including by invoking: (1) its reserved jurisdiction over permits under Water Code Section 1394; (2) its continuing authority to prevent the waste, unreasonable use, or unreasonable method of use of water under the California Constitution, Article X, Section 2; or (3) its continuing authority to protect public trust uses of water.

California law recognizes several types of rights to surface water, of which riparian and appropriative rights are the most common. A riparian right exists by reason of ownership of land abutting a stream or other body of water. The right allows a water user to divert from the natural flow of a stream for use on land within the watershed of the source. Seasonal storage of water is not allowed under a riparian right. In general, riparian water users have first priority to the use of the natural flow in a river. Water remaining after riparian users have taken their share is available to appropriators.

An appropriative water right consists of the right to divert a specified quantity of water for a reasonable, beneficial use. Appropriative rights carry a priority relative to other appropriative rights. The water user who is first in time is entitled to the full quantity of water specified under the right before junior appropriators may exercise their rights. Since December 19, 1914, the effective date of the Water Commission Act of 1913, the acquisition of an appropriative right requires a person to obtain a permit or license from the State Water Board or its predecessor agencies. Appropriative water rights fall into two general categories: pre-1914 appropriative water rights and post-1914 appropriative water rights. No permit or license is necessary to divert water under claim of pre-1914 appropriative right.

To obtain a new appropriative water right, a person must file a water rights application with the State Water Board to appropriate water, obtain a water right permit, and use the water in accordance with the permit for a reasonable and beneficial purpose. In acting on an application, the State Water Board considers a number of factors, including whether water is available for appropriation, whether the water will be put to beneficial use, and whether it is necessary to impose conditions to protect the environment, the public trust, and prior rights, including conditions to carry out water quality control plans. If the water is diverted and used in accordance with the terms of the permit, a license eventually will be issued confirming the extent of the appropriative right.

1.5 State Water Board Actions

The State Water Board is considering amendments to the 2006 Bay-Delta Plan, which was adopted by the State Water Board by Resolution No. 2006-0098 on December 13, 2006. The 2006 Bay-Delta Plan identified a number of emerging issues that required additional evaluation and water quality control planning. Two of the emerging issues identified for further evaluation and prioritization were SJR flows and southern Delta salinity (State Water Board 2006), which are the focus of the State Water Board's current planning efforts and this SED. In July 2008, the State Water Board adopted the *Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* and expressed its intent to review and potentially modify the SJR flow and southern Delta salinity objectives. The State Water Board again identified these issues for further review in the *2009 Staff Report on the Periodic Review of the 2006 Bay-Delta Plan*, adopted by Resolution No. 2009-0065 on August 4, 2009.

This is a recirculated SED. On February 13, 2009, the State Water Board initiated the review and potential amendment of the Bay-Delta Plan. It issued two notices: (1) a notice of preparation (NOP) and a scoping meeting notice for environmental documentation for the update and implementation of the Bay-Delta Plan relating to the southern Delta salinity and LSJR flow objectives; and (2) a notice of public staff workshop to receive information regarding potential amendments to the objectives. On April 1, 2011, the State Water Board issued a revised NOP and notice of an additional scoping meeting for June of 2011. The State Water Board also held several other public meetings and workshops to receive information and conduct discussions regarding issues related to the potential plan amendments.

1.5.1 Lower San Joaquin River Flows

This section describes the State Water Board's past actions and proposed plan amendments related to LSJR flows.

Flow Objectives Background

Storage reservoirs were constructed in the SJR Basin beginning in the 1940s through the 1970s. These storage reservoirs were constructed by local irrigation districts and as part of the larger federal CVP. The SJR flows at Vernalis and in the three eastside tributaries are generally much lower than the natural peaks in flow that would have occurred in spring and early summer because of reservoir storage and diversions. At the same time, the natural low flow periods of the late summer and early fall have been elevated at times due to agricultural return flows and power generation releases of previously stored water. The flow changes and physical habitat modification activities (e.g., gravel mining) have resulted in poor habitat conditions for native fishes and native LSJR fish populations (e.g., Chinook salmon and Central Valley steelhead) have declined.

The State Water Board first established flow objectives for the SJR at Vernalis in the 1995 Bay-Delta Plan to protect fish and wildlife beneficial uses. These SJR flow objectives were primarily intended to protect anadromous species (ocean-going fish that migrate upstream to spawn), such as fall-run Chinook salmon, which use the three eastside tributaries.[5] They were also intended to provide incidental benefits to Central Valley steelhead. The State Water Board set different numeric

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[5] The State Water Board established a narrative objective for salmon protection that is consistent with the anadromous fish doubling goals of the Central Valley Project Improvement Act (CVPIA).

objectives based on water year type for three time periods: February–June, excluding April 15–May 15 (spring flows); April 15–May 15 (pulse flows); and October (fall flows). The spring flows were intended to provide minimum net downstream freshwater flows in the SJR to address habitat concerns from reduced flows and water quality degradation. The pulse flows were developed to increase the success of Chinook salmon smolt outmigration from the SJR through the Bay-Delta. The fall flows were developed to provide attraction flows for adult salmon returning to the SJR Watershed to spawn. The spring flow and pulse flow objectives include two levels for each time period. The trigger for the higher flow is linked to the February–June Delta outflow objectives (X2),[6] which are based on hydrologic conditions in the Sacramento River Basin and the SJR Basin.

In Water Right Decision 1641 (revised March 15, 2000), the State Water Board allocated responsibility for meeting the SJR flow objectives in the 1995 Bay-Delta Plan to the U.S. Bureau of Reclamation (USBR). In order to obtain additional scientific information on which to base future objectives, in the State Water Board's Water Right Decision 1641 (D-1641), the State Water Board also approved the Vernalis Adaptive Management Plan (VAMP) experiment proposed by parties to the San Joaquin River Agreement in lieu of meeting the pulse flow objectives included in the 1995 Bay-Delta Plan. VAMP, which was initiated in 2000 and expired in 2011, was a large-scale, experimental management program that was designed to determine how juvenile fall-run Chinook salmon survival rates change in response to alterations in SJR flows and CVP and SWP exports, and with the installation of a permanent barrier at the head of Old River (HORB) (which was never permanently installed). The VAMP experiment, which was implemented for a 31-day period each year during April and May, was designed to assess a combination of SJR flows, varying between 3,200 cubic feet per second (cfs) and 7,000 cfs, and exports varying between 1,500 and 3,000 cfs. Information from the VAMP experiment was intended to inform potential changes to the SJR flow objectives. For various reasons, however, VAMP was not implemented as originally designed. In the 2006 Bay-Delta Plan, the flow objectives were not modified, but the program of implementation was changed to allow for the ongoing staged implementation of the pulse flow objectives through VAMP. In addition, as discussed above, SJR flows were identified as an emerging issue requiring additional consideration to address ongoing population declines of salmonids and the effect of SJR flows on pelagic organisms.

Other flow requirements for the SJR, including Endangered Species Act (ESA) biological opinion requirements and Federal Energy Regulatory Commission (FERC) licensing requirements are described in Chapter 2, *Water Resources*, and Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*.

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[6] X2 is the location of the 2 parts per thousand salinity contour (isohaline), 1 meter off the bottom of the estuary measured in kilometers upstream from the Golden Gate Bridge. The abundance of several estuarine species has been correlated with X2. In the 2006 Bay-Delta Plan, a salinity value--or electrical conductivity (EC) value--of 2.64 millimhos/centimeter (mmhos/cm) is used to represent the X2 location. Note, in this SED, EC is generally expressed in deciSiemens per meter (dS/m). The conversion is 1 mmhos/cm = 1 dS/cm.

Proposed Amendments

The State Water Board is considering amending the Bay-Delta Plan to establish new flow objectives on the LSJR and its three eastside tributaries to protect fish and wildlife beneficial uses. These objectives would establish flows sufficient to support and maintain the natural production of fish populations in the plan area. The flows are intended to mimic the natural hydrograph with respect to relative magnitude, duration, timing, and spatial extent of flows. The objectives also require a percentage of unimpaired flows to be maintained. The alternatives evaluated in this SED include implementation of the flow objectives by a range of percentages of unimpaired flow during the February–June period. Unimpaired flow represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization. The program of implementation of the flow objectives also provides flexibility to adaptively manage flows outside of the February–June time period. The LSJR alternatives are listed below, including the No Project Alternative, which must be evaluated under CEQA.

- LSJR Alternative 1, the No Project Alternative, would continue the flow requirements as established in the 2006 Bay-Delta Plan and implemented through D-1641; this also includes continuation of, and full compliance with, the southern Delta salinity objectives as described in SDWQ Alternative 1.
- LSJR Alternative 2 would establish a range between 20 and 30 percent, with 20 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 3 would establish a range between 30 and 50 percent, with 40 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 4 would establish a range between 50 and 60 percent, with 60 percent as the starting percentage of unimpaired flow in the program of implementation.

The program of implementation for LSJR alternatives 2, 3, and 4 also describes the potential State Water Board actions listed below.

- How the State Water Board could use adaptive implementation to implement the flow objectives.
- The water rights actions that will be taken by the State Water Board to implement the flow objectives.
- Other State Water Board implementation actions to implement the flow objectives, including modification of hydropower project FERC license requirements through the FERC hydropower relicensing process.
- Non-flow measures that could be used to support and maintain the natural production of fish populations in the plan area.
- Special studies, reporting, and monitoring.

As noted at the beginning of this document, the State Water Board's Phase III would specifically identify the water rights that could be modified as a result of adopting and applying the program of implementation for the LSJR flow objectives analyzed in this SED as part of Phase I. Details of the

LSJR alternatives are provided in Chapter 3, *Alternatives Description*, and the language of the amended WQCP is included in Appendix K, *Revised Water Quality Control Plan.*

1.5.2 Southern Delta Water Quality

This section describes the State Water Board's past actions and proposed plan amendments related to southern Delta water quality.

Water Quality Objectives Background

Elevated salinity in the southern Delta is caused by various factors, including low flows; salts imported to the SJR Basin in irrigation and wetland supply water; municipal discharges; subsurface accretions from groundwater; tidal actions; diversions of water by the CVP, SWP, and local water users; channel capacity; and agricultural drainage discharges to the SJR upstream of the Delta and in the Delta. Poor flow or circulation patterns in the southern Delta waterways also cause localized increases in salinity concentrations.

The State Water Board established the current southern Delta salinity objectives for the protection of agricultural beneficial uses in the 1978 Delta Plan. The 1978 Delta Plan includes salinity objectives, in the form of electrical conductivity (EC),[7] for the protection of agriculture in the southern Delta at four compliance locations including: the SJR at Vernalis, the SJR at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge. The approach used in developing the objectives involved an initial determination of the water quality needs of significant crops grown in the area, the predominant soil type, and local irrigation practices. In addition, the extent to which these water quality needs would be satisfied under "without project" (without the CVP and SWP) conditions was also considered. The State Water Board based the southern Delta EC objectives on the calculated maximum salinity of applied water (assuming no precipitation) that sustains 100 percent yields of two important salt-sensitive crops grown in the southern Delta (beans and alfalfa) in conditions typical of the southern Delta (surface irrigation of mineral soils) per the *University of California Guidelines and Irrigation and Drainage Paper 29: Water Quality for Agriculture of the Food and Agriculture Organization of the United Nations* (State Water Board 1978, page VI-16 – VI-19). The State Water Board set an objective of 0.7 deciSiemens per meter (dS/m) during the summer irrigation season (April 1–August 31) based on the salt sensitivity and growing season of beans and an objective of 1.0 dS/m during the winter irrigation season (September 1–March 31) based on the growing season and salt sensitivity of alfalfa during the seedling stage. In the 1978 Delta Plan, the State Water Board found that the most practical solution for long-term protection of southern Delta agriculture was construction of physical facilities to provide adequate circulation and substitute supplies.

The State Water Board delayed implementation of the southern Delta salinity objectives pending negotiations by the California Department of Water Resources (DWR), USBR, and the South Delta Water Agency (SDWA) concerning construction of physical facilities to protect agriculture in the southern Delta (permanent barriers or other devices). Because the negotiations were never completed, the 1991 Bay-Delta Plan provided for a staged implementation of the objectives.

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[7] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

The 1991 Bay-Delta Plan called for implementation of the objectives at Vernalis and Brandt Bridge by 1994 and implementation of the objectives at the two Old River sites by 1996 unless a three-party agreement was reached between DWR, USBR, and SDWA. In the 1995 Bay-Delta Plan, the State Water Board further delayed implementation of the EC objectives for the two Old River sites until December 31, 1997.

In D-1641, the State Water Board authorized a staged implementation of the southern Delta EC objectives. Pursuant to D-1641, USBR was required to meet the Vernalis EC objectives using any measures available. DWR and USBR also were required to meet an EC objective of 1.0 dS/m at Brandt Bridge on the SJR, Old River near Middle River, and Old River at Tracy Road Bridge (collectively, the interior southern Delta stations) September–March, and April–August, until April 1, 2005. As of April 1, 2005, D-1641 required that DWR and USBR, through their water right permits and license, meet an EC objective of 0.7 dS/m April–August at the interior southern Delta stations unless permanent barriers were constructed or equivalent measures were implemented to protect southern Delta agriculture along with an operations plan. As discussed below in Section 1.5.3, *Related Litigation*, the appellate court reviewing D-1641 struck down the provision allowing 1.0 dS/m at the interior salinity stations for April–August if such measures were taken. Accordingly, the objectives in the 2006 Bay-Delta Plan are in effect: 0.7 dS/m for April–August, and 0.7 dS/m for September–March.

Since 1991, DWR has installed temporary rock barriers in the southern Delta at three locations to improve water levels, circulation patterns, and water quality in the southern Delta for local agricultural diversion.[8] DWR and USBR were planning to construct permanent physical facilities in the form of permanent operable gates (known as the South Delta Improvements Program) that would have provided better compliance with the objectives. However, the permanent facilities have not been constructed to date, and their construction is unlikely to occur due to endangered species concerns. The National Marine Fisheries Service (NMFS) biological opinion (BO) Stanislaus River reasonable and prudent alternative, including Action 3.1.3 (NMFS BO) was issued in June 2009 and specifically directs DWR to halt implementation of the South Delta Improvements Program. NMFS has indicated that consultation for the program cannot be reinitiated until after 3 years of fish predation studies at the southern Delta temporary barriers are completed. The studies were completed in 2011, and DWR is currently working with NMFS. After all permits have been acquired DWR can proceed with construction; however, there is not a schedule available for project completion at this time.

In 2006 the State Water Board issued a cease and desist order (CDO) against USBR and DWR for threatened violation of the interior southern Delta salinity objectives that imposed a time schedule for compliance with the objectives (State Water Board Order WR 2006-0006). In 2010, the State Water Board issued Order WR 2010-0002 modifying Order WR 2006-0006. The modified order amends the compliance schedule in Order WR 2006-0006 and imposes other interim measures. As an example, pursuant to Condition 5 of Order WR 2010-0002, DWR, in cooperation with USBR, is required to continue implementing temporary barriers in the southern Delta and is required to pursue and implement feasible improvements to the temporary barriers. Pursuant to Condition 7 of Order WR 2010-0002, DWR and USBR are also required to study the feasibility of controlling salinity by implementing measures other than the temporary barriers project, such as the feasibility of installing low lift pumps. Order WR 2010-0002 also delegates to the State Water Board Executive

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[8] DWR is the lead agency pursuant to CEQA and has prepared several environmental documents for construction and operations of the barriers.

Director the authority to require DWR and USBR to implement, on an interim basis, any alternative salinity control measures that the Executive Director determines are reasonable and feasible, based on the feasibility study.

Under the current objectives and methods for determining compliance, there have been many instances of exceedance of the EC objective in the southern Delta, in particular at the Old River near Tracy Road Bridge, Station P-12. Typically exceedance occurs due to dry hydrologic conditions in the Sacramento River and SJR Basins and degradation occurring downstream of Vernalis. The proposed interior southern Delta salinity compliance locations are comprised of three river segments rather than the current three specific point locations so that compliance measurements can be determined that will best represent and protect the beneficial uses in a an environment subject to alternating tidal flows. To facilitate this effort, DWR and USBR will work with State Water Board staff and solicit stakeholder input to develop and implement a special study to characterize the spatial and temporal distribution and associated dynamics of water level, flow, and salinity conditions in the southern Delta waterways. The study will identify the extent of low or null flow conditions and associated concentrations of local salt discharges. DWR and USBR's water rights will then be conditioned to require gathering of information to determine the appropriate locations and methods to assess attainment of the salinity objectives in the interior southern Delta.

Proposed Amendments

The existing SDWQ objectives for salinity identified in the 2006 Bay-Delta Plan would be amended to continue to protect agricultural beneficial uses in the southern Delta. The alternatives evaluated in this SED are listed below, including the No Project Alternative, which must be evaluated under CEQA.

- SDWQ Alternative 1, the No Project Alternative, would continue the 2006 Bay-Delta Plan southern Delta salinity objectives and require full compliance with1.0 dS/m September–March and 0.7 dS/m April–August in the southern Delta and Vernalis; and continued conditioning of the DWR's and USBR's water rights to meet the interior southern Delta objectives and the USBR's water rights to meet the Vernalis objective. This also includes continuation of, and full compliance with, the SJR flow requirements as established in the 2006 Bay-Delta Plan as described in LSJR Alternative 1.
- SDWQ Alternative 2 would establish an annual 1.0 dS/m salinity objective for the southern Delta and Vernalis and would require continued conditioning of the DWR's and USBR's water rights to meet the interior southern Delta objectives. This alternative would also change the three interior southern Delta compliance locations. Instead of compliance being determined at the current compliance monitoring points (stations), the objective would be applicable in specified segments of the SJR, Middle River, and Old River/Grant Line Canal affecting agricultural beneficial uses. USBR's water rights would continue to be conditioned to meet EC levels of 0.7 dS/m August and 1.0 dS/m from September–March in the SJR at Airport Way Bridge near Vernalis to provide assimilative capacity for salinity inputs downstream of Vernalis. Various study, planning and monitoring requirements would also be imposed.
- SDWQ Alternative 3 would establish an annual 1.4 dS/m salinity objective for the southern Delta and Vernalis and would require continued conditioning of the DWR's and USBR's water rights to meet the interior southern Delta objectives. This alternative would also change the three interior southern Delta compliance locations. Instead of compliance being determined at the current compliance monitoring point stations, the objective would be applicable in specified

segments of the SJR, Middle River, and Old River/Grant Line Canal affecting agricultural beneficial uses. USBR's water rights would continue to be conditioned to meet EC levels of 0.7 dS/m from April–August and 1.0 dS/m from September–March in the SJR at Airport Way Bridge near Vernalis to provide assimilative capacity for salinity inputs downstream of Vernalis. Various study, planning and monitoring requirements would also be imposed

Details of the SDWQ alternatives are provided in Chapter 3, *Alternatives Description*, and the language of the amended WQCP is included in Appendix K, *Revised Water Quality Control Plan*.

1.5.3 Related Litigation

This section discusses litigation related to the establishment and implementation of water quality objectives in the 2006 Bay-Delta Plan and D-1641.

In 2006, the Third District Court of Appeal in *State Water Resources Control Board Cases* 136 Cal. App.4th 674 issued a decision addressing challenges to the State Water Board's adoption of D-1641and CEQA compliance. The court rejected the CEQA challenges and, in large part, upheld D-1641 but concluded that when a WQCP calls for an objective to be achieved by allocating responsibility to meet that objective in a water rights proceeding, the water right decision must fully implement that objective. Accordingly, the court determined that the State Water Board failed to fully implement the Vernalis pulse flow objective in the 1995 Bay-Delta Plan by instead allowing the immediate implementation of an alternate experimental flow regime under VAMP, thus accomplishing a de facto amendment of the Bay-Delta Plan without complying with the procedural requirements for amending such a plan. The court also found that the State Water Board failed to adequately implement the southern Delta salinity objectives at the three interior Delta locations by delaying implementation of the 0.7 dS/m objective at those locations. The court required a writ of mandate be issued commanding the State Water Board to commence proceedings to either assign responsibility for meeting the Vernalis pulse flow objective and the southern Delta salinity objectives in the 1995 Bay-Delta Plan or to modify those objectives. The State Water Board complied with the writ by amending the 2006 Bay-Delta Plan to allow staged implementation of the Vernalis pulse flow objective (through the target flows in VAMP) and by commencing the current project to evaluate the southern Delta salinity objectives and program of implementation.

Implementation of the southern Delta salinity objectives is at issue in *City of Tracy v. California State Water Resources Control Board* (Sacramento Superior Court Case No. 34-2009-80000392). In this case, the City of Tracy (Tracy) challenged the State Water Board's 2009 decision to remand the National Pollutant Discharge Elimination System permit issued by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) for Tracy's wastewater treatment plant. The State Water Board had partially remanded the permit to the Central Valley Water Board to include more rigorous requirements (including final water quality-based effluent limitations) to implement the southern Delta salinity objectives. In part, Tracy challenged the applicability of the salinity objectives in the underlying Bay-Delta Plan, arguing that they were never properly adopted and that the 2006 amendments did not provide an adequate program of implementation for municipal dischargers. The Central Valley Clean Water Association intervened in the litigation, representing municipal dischargers in the Central Valley. In 2011, the trial court ruled against the State Water Board, concluding that the State Water Board failed to comply with Water Code Section 13241 when it established the water quality objectives for EC in 1978 and that the Bay-Delta Plan's program of implementation was inadequate in relation to municipal dischargers. The trial court issued a writ ordering the State Water Board to vacate the portions of the Tracy order relating to the effluent limitations for EC and to revise the order consistent with the court's decision, and requiring the Board to consider Water Code Section 13241's factors in establishing the salinity objective and to adopt a program of implementation describing the nature of actions for municipal dischargers to achieve the salinity objective. The State Water Board did not appeal.

1.6 References Cited

State Water Resources Control Board (State Water Board). 1978. *Water Quality Control Plan for the Sacramento–San Joaquin Delta and Suisun Marsh*. August. Available: http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/docs/1978wqcp.pdf.

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Chapter 2
Water Resources

This chapter discusses existing surface and groundwater resources and the management of those resources within the plan area and extended plan area, as described in Chapter 1, *Introductio*n, as well as resources upstream that drain to the plan area and extended plan area. The information in this chapter provides context for the description of the Lower San Joaquin River (LSJR) alternatives and southern Delta water quality (SDWQ) alternatives in Chapter 3, *Alternatives Description*. As needed, this recirculated substitute environmental document (SED) present additional existing setting and modeling information for each relevant resource area and impact analysis.

This chapter is generally organized by large geographic areas within the plan area: the San Joaquin River (SJR) Basin, Delta, and San Joaquin Groundwater Basin. Section 2.1, *Overview*, provides a general overview of the existing surface, delta, and groundwater resources within the SJR Basin, Delta, and San Joaquin Groundwater Basin and the water supply and uses those resources provide. Sections 2.2 through 2.6 further discuss surface water resources by tributary from south to north (upstream to downstream) in the SJR Basin, including the operation of rim dams[1] for hydropower and water storage, existing water diversions, current flow requirements for fish protection, and hydrology (unimpaired and historical flow). Section 2.7, *Southern Delta*, describes existing salinity and water quality conditions and water management in the southern Delta that influence water quality. Management, in this context, includes operations of the Central Valley Project (CVP) and State Water Project (SWP), existing water diversions, and existing municipal and agricultural drainage discharges. Finally, Section 2.8, *San Joaquin Valley Groundwater Basin*, describes general characteristics of existing groundwater resources within the San Joaquin Groundwater Basin geographically from north to south.

2.1 Overview

This section generally describes the surface and groundwater resources located within the SJR Basin, the Delta, and the San Joaquin Valley Groundwater Basin that occur primarily within in the plan area and the extended plan area and that could be affected by the LSJR alternatives. Major water supplies and uses are summarized.

2.1.1 San Joaquin River Basin

The Central Valley Basin of California is surrounded by mountains except for a narrow gap on its western edge at the Carquinez Strait. Streamflow in the Central Valley is chiefly derived from runoff from the Cascade and Sierra Nevada ranges, with minor amounts from the Coast Ranges. Precipitation varies, with approximately four-fifths of the total occurring between the end of October and the beginning of April. Snowpack in the high Sierra delays runoff until the snow melts,

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[1] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

typically in April, May, and June. Normally, approximately half of the annual runoff occurs in these months. The 450-mile-long Central Valley Basin of California is divided into the Sacramento Valley in the north and the San Joaquin Valley in the south. The San Joaquin Valley spans two basins: the SJR Basin and the Tulare Lake Basin (DWR 2009). These two basins are distinct drainage areas separated by a low divide formed by coalescing alluvial fans. The divide lies between the SJR to the north, part of which is in the plan area and extended plan area, and Kings River to the south, which is not in the plan area or extended plan area (Figure 2-1a shows the SJR Basin).

The SJR Basin drains approximately 15,550 square miles of the Sierra Nevada and the southern portion of the Central Valley of California. The headwaters of the SJR are on the western slope of the Sierra Nevada at elevations in excess of 10,000 feet (ft). The Upper SJR and the LSJR tributaries drain large areas of high-elevation watersheds that supply snowmelt runoff during the late spring and early summer. Other SJR tributaries on the east side of the SJR Basin include the Chowchilla and Fresno Rivers, which drain the Sierra Nevada foothills. Most of the runoff in these smaller SJR tributaries results from rainfall, which is stored in reservoirs for irrigation purposes. A few small tributaries to the west, with headwaters in the rain shadow of the Coast Ranges, contribute little flow to the LSJR.

At the foot of the mountains (in the foothills), the SJR is impounded by Friant Dam, which forms Millerton Lake. The SJR reaches the valley floor near Fresno. Infrequent floodwaters from the Kings River flow into the SJR at Mendota Pool reservoir via the Fresno Slough. The river then flows north-northwest, and three eastside tributaries[2] enter it before it flows into the southern Delta at Vernalis (Vernalis is a unincorporated community in San Joaquin County downstream of the Stanislaus River and upstream of tidal effects from the Delta, where the LSJR enters the southern Delta).

In the Upper SJR, Friant Dam diverts water into the Friant-Kern and Madera canals. Until the SJR Restoration Program[3] began in 2009, only a small seasonal flow (125 cubic feet per second [cfs] maximum) was released from Friant Dam for downstream riparian water uses. Flood control releases have frequently been necessary in above-normal and wet years.[4] Downstream of Friant Dam, the primary sources of surface water to the SJR are its three eastside tributaries that drain the western slope of the Sierra Nevada. Table 2-1 summarizes the SJR Basin characteristics and existing reservoirs the tributaries.

In this document, the LSJR is defined as the portion of the SJR between its confluence with the Merced River and downstream to Vernalis. It receives flow from the three eastside tributaries. These tributaries provide the primary sources of surface water to the LSJR together with flow from the Upper SJR. The LSJR extends through San Joaquin, Stanislaus, and Merced Counties. The three eastside tributaries and rim dams, New Melones, New Don Pedro, and New Exchequer, are located in several different counties. Table 2-2 and Figure 2-1b identify the tributaries, rim dams, and localities within the plan area and extended plan area.

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[2] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[3] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future.

[4] Flows released from Friant Dam for fish protection or for flood control would contribute to the SJR flow at Vernalis, but they are not part of the plan amendments or alternatives evaluated in this document as described in Chapter 3, *Alternatives Description*.

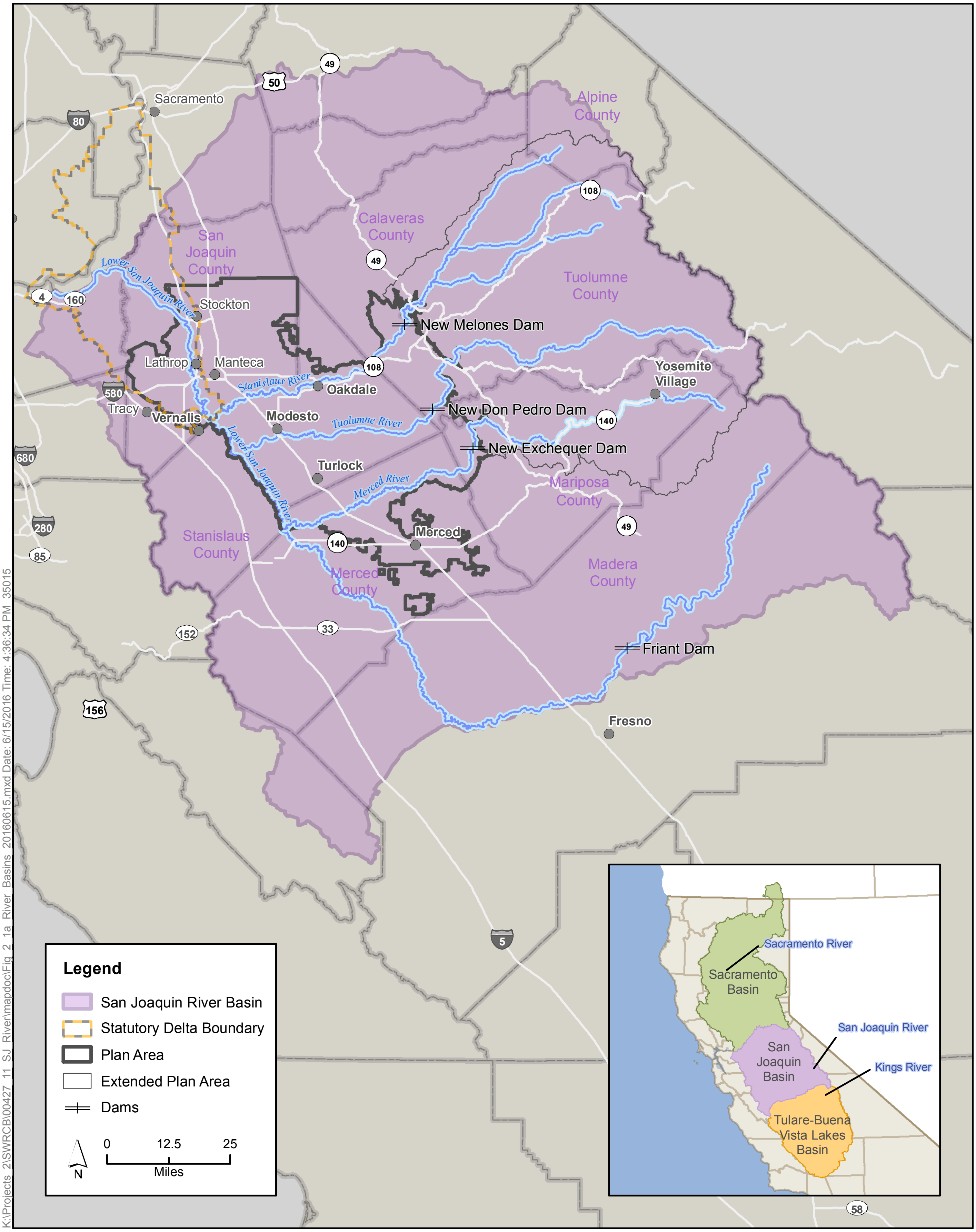

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Figure 2-1a
Central Valley Basin and San Joaquin River Basin

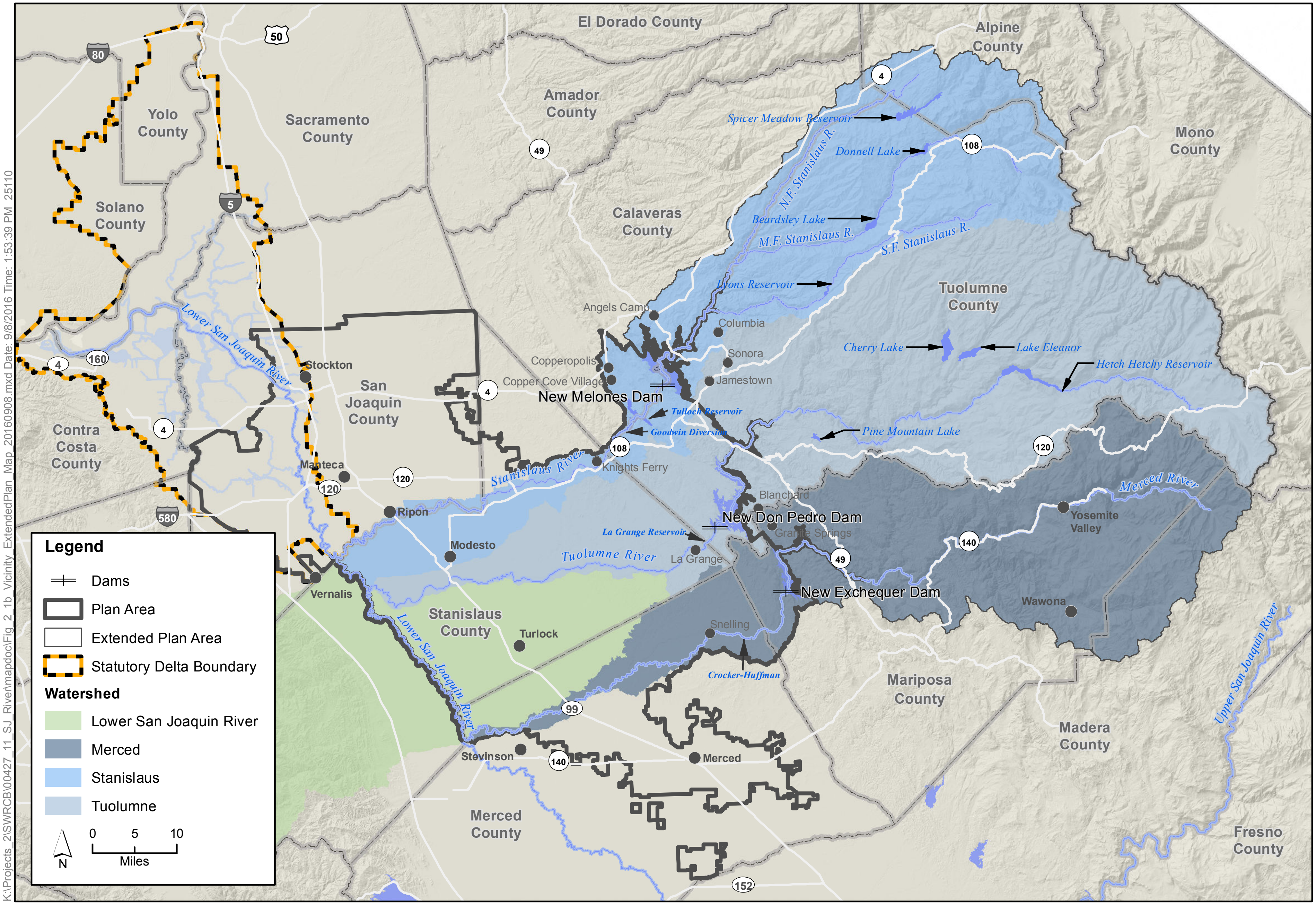

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Figure 2-1b
Vicinity Map of Plan Area and Extended Plan Area

Table 2-1. Summary of Watershed and Reservoir Characteristics in San Joaquin River Basin

	Lower San Joaquin River			
Characteristic	Stanislaus River	Tuolumne River	Merced River	Upper San Joaquin River
Median annual unimpaired flow (1923–2008)[a]	1.08 MAF	1.72 MAF	0.85 MAF	1.44 MAF (upstream of Friant Dam)
Drainage area of tributary at confluence SFR —(and percent of tributary upstream of mouth)[b]	1,195 square miles (82% upstream of Goodwin)	1,870 square miles (82% upstream of La Grange)	1,270 square miles (84% upstream of Merced Falls)	1,675 square miles (100% upstream of Friant Dam)
Total river length	161 miles	155 miles	135 miles	330 miles
Miles downstream of major dam	New Melones: 62 miles Goodwin: 59 miles	New Don Pedro: 55 miles La Grange: 52 miles	New Exchequer: 63 miles Crocker Huffman: 52 miles	Friant: 266 miles
Confluence with LSJR—River Miles (RM) upstream of Sacramento River confluence	RM 75	RM 83	RM 118	RM 266
Number of dams[c]	28 DSOD[d]	27 DSOD	8 DSOD	19 DSOD
Total reservoir storage[c]	2.85 MAF	2.94 MAF	1.04 MAF	1.15 MAF
Most downstream dam (with year built and capacity)[e]	Goodwin, 59 miles upstream of LSJR (1912, 500 AF).	LaGrange, 52 miles upstream of LSJR (1894, 500 AF).	Crocker-Huffman, 52 miles upstream of LSJR (1910, 200 AF).	Friant, 260 miles upstream of the Merced confluence (1942, 520 TAF)
Major downstream dams (with year built and reservoir capacity)[e]	New Melones (1978, 2.4 MAF) ; Tulloch, Beardsley, Donnells "Tri-dams project" (1958, 203 TAF)	New Don Pedro (1970, 2.03 MAF)	New Exchequer/Lake McClure (1967, 1.02 MAF); McSwain (1966, 9.7 TAF)	Friant (1942, 520 TAF)
Major upstream dams (with year built and reservoir capacity)	New Spicer Meadows (1988, 189 TAF)	O'Shaughnessy/Hetch Hetchy Reservoir (1923, 360 TAF); Cherry Valley (1956, 273 TAF)	None	Shaver Lake (1927, 135 TAF); Thomas Edison Lake (1965, 125 TAF); Mammoth Pool (1960, 123 TAF)

Source: Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives.*

MAF = million acre-feet; RM = river mile; DSOD = Division of Safety of Dams; AF = acre feet; TAF = thousand acre-feet

[a] Median annual unimpaired flow adjusted from Cain et al. 2003.

[b] Source: NRCS Watershed Boundary Dataset (2009).

[c] Source: Cain et al. 2003.

[d] DSOD dams are those greater than 50 feet in height and/or greater than 50 acre-feet of capacity, with some exceptions.

[e] Source: Cain et al. 2003.

Table 2-2. Location of LSJR Tributaries and Rim Dams

River	Rim Dam/ Reservoir	Downstream Dam(s)	Plan Area Counties	Extended Plan Area Counties	Communities within General Proximity of the Rim Dams
Stanislaus	New Melones/ New Melones	Tulloch Goodwin	Calaveras Tuolumne San Joaquin	Alpine Calaveras Tuolumne	Angels Camp, Copperopolis, Columbia, Sonora, Jamestown, Copper Cove
Tuolumne	New Don Pedro/ New Don Pedro	La Grange	Tuolumne Stanislaus	Tuolumne	Blanchard, Granit Springs
Merced	New Exchequer/ Lake McClure	Crocker Huffman	Mariposa Merced	Mariposa Madera	Granite Springs

The hydrology of the LSJR tributaries and the SJR at Vernalis is dominated by precipitation in winter and early spring and snowmelt runoff in late spring and early summer (McBain and Trush 2002). The components of the unimpaired flow[5] regime in the Sierra Nevada are fall and winter storms (rainfall-runoff), spring snowmelt, and summer declining base flow (McBain and Trush 1999; Cain et al. 2003). In recent years, only a small fraction of the estimated unimpaired flow reaches Vernalis, except in high runoff years (e.g., 1986). During these high runoff years, flood control releases are made and a majority of the unimpaired runoff reaches Vernalis. In most years, a large fraction of the unimpaired flow is diverted directly for beneficial uses, such as irrigation or diverted to storage reservoirs for later use. Construction of storage reservoirs with hydropower diversions in the Sierra Nevada and the major tributary reservoirs with irrigation diversions in the Central Valley have greatly altered the natural flow regime of the LSJR and the three eastside tributaries (McBain and Trush 1999; Kondolf et al. 2001; Cain et al. 2003; Brown and Bauer 2009).

2.1.2 Delta

The Delta, with legal boundaries established by California Water Code Section 12220, encompasses a 738,000-acre area generally bordered by the cities of Sacramento, West Sacramento, Stockton, Tracy, Antioch, and Pittsburg (Figure 2-2). This former wetland area has been reclaimed into more than 60 islands and tracts, 700 miles of waterways, and roughly 520,000 acres devoted primarily to farming (CALFED 2005). The largest source of fresh water for the Delta is the Sacramento River, which transports an average of approximately 18.3 million acre-feet (MAF) per year into the Delta (DWR 2012). Additional flows from the Yolo Bypass, the LSJR, the Mokelumne River, and the Cosumnes River contribute an average of 5.8 MAF, with Delta precipitation adding approximately another 1.0 MAF (DWR 2009, 2012). Of the 5.8 MAF contributed from sources to the south of the Delta, an average of 1.9 MAF comes from the three LSJR tributaries. During low-flow periods, the hydrodynamics of the channels within the Delta are influenced primarily by the tides, with secondary effects from inflows and CVP and SWP exports (Burau et al. 1999; Kimmerer 2004).

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[5] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

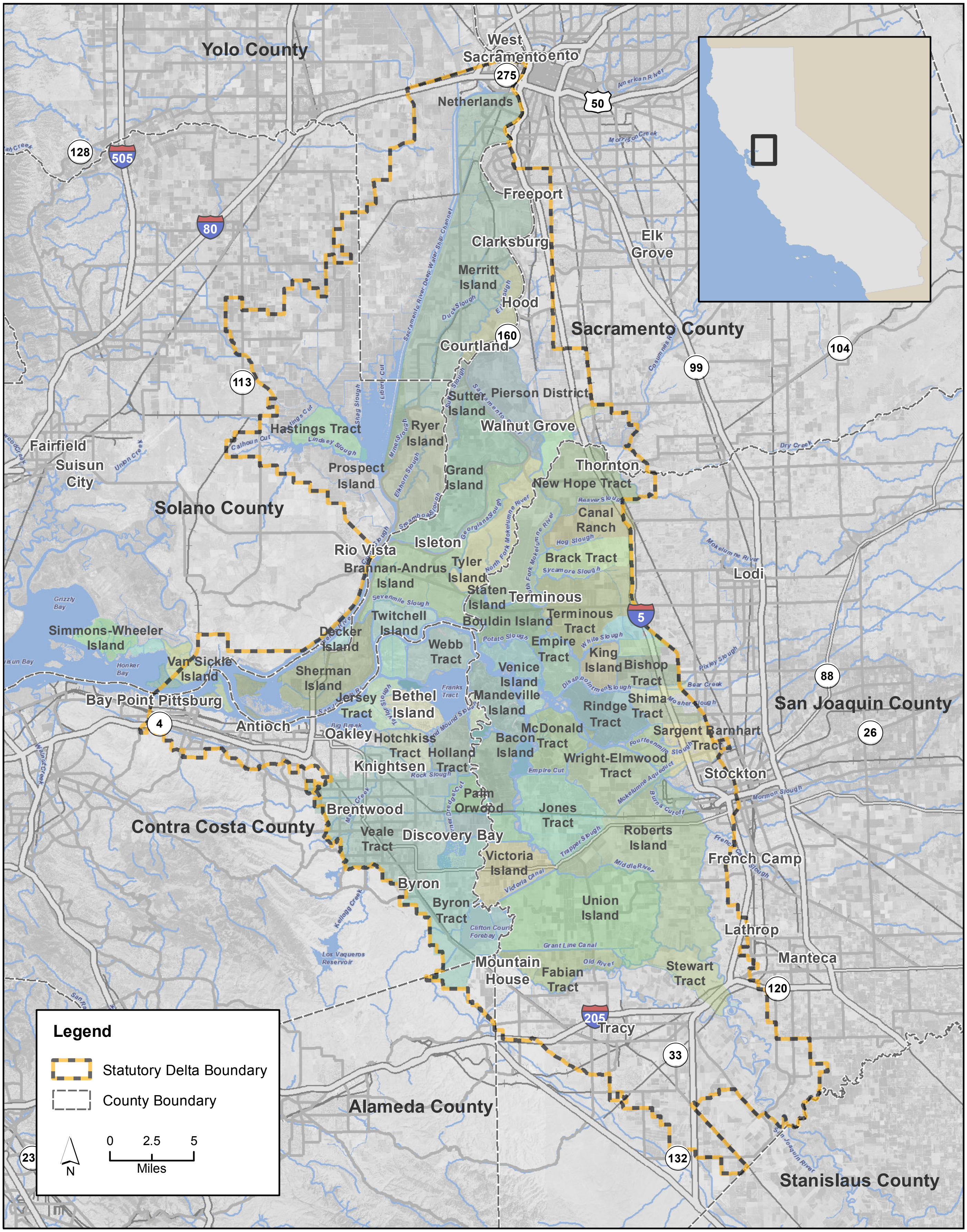

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Figure 2-2
The Sacramento–San Joaquin Delta

Tidal rise and fall varies with location, from less than 1 foot in the eastern Delta to more than 5 ft in the western Delta (DWR 2009). Approximately half of the tidal flows follow the Sacramento River channel and about half follow the SJR channel into the southern Delta. The magnitude and movement of tidal flows diminish at locations farther into the Delta, and one-directional riverine movement begins to become more prominent. The twice-daily tides and varying inputs from rivers and streams result in highly dynamic Delta conditions that change continuously (Deltares 2009).

Major diversions in the southern Delta include the SWP (Banks Pumping Plant), CVP (Jones Pumping Plant), and Contra Costa Water District (CCWD). Both the CVP and the SWP use Delta channels to convey water released from the upstream Sacramento River Basin reservoirs to pumping stations in the southern Delta. The use of the Delta channels to convey water from the northern Delta to the southern Delta export facilities modifies the natural net flow patterns (i.e., direction) in some of the southern Delta channels (i.e., Old and Middle Rivers).

The southern portion of the Delta overlies the Tracy Groundwater Subbasin. The Tracy Subbasin is defined by the areal extent of unconsolidated to semiconsolidated sedimentary deposits that are bounded by the Diablo Range on the west, the Mokelumne River and SJR on the north, the SJR on the east, and the San Joaquin–Stanislaus County line on the south. The Eastern San Joaquin Subbasin is adjacent to the east of the Tracy Subbasin and the Delta-Mendota Subbasin is adjacent to the south. These subbasins are all within the San Joaquin Valley Groundwater Basin. The Tracy Subbasin lies south of the Sacramento Valley Groundwater Basin and Solano Subbasin. The Tracy Subbasin is drained by the SJR and one of its major westside tributaries, Corral Hollow Creek (DWR 2003f).

2.1.3 San Joaquin Valley Groundwater Basin

The plan area lies within the northern portion of the San Joaquin Valley Groundwater Basin. This portion of the San Joaquin Valley Groundwater Basin, as defined in the California Department of Water Resources (DWR) Bulletin 118,[6] approximately coincides with the western portion of the River (SJR) Hydrologic Region. The SJR Hydrologic Region covers approximately 3.73 million acres of the larger San Joaquin Valley Groundwater Basin, with the remaining 5 million acres in the Tulare Lake Hydrologic Region.

The San Joaquin Valley Groundwater Basin is comprised of 17 subbasins, of which 9 subbasins underlie within the SJR Hydrologic Region. Two additional groundwater basins, the Los Banos Creek Valley Basin and Yosemite Valley Basin, are not part of the San Joaquin Valley Groundwater Basin, but also underlie the SJR Hydrologic Region. The plan area lies almost entirely within the boundaries of four subbasins on the east side of the San Joaquin Valley Groundwater Basin: Eastern San Joaquin, Modesto, Turlock, and Merced (Figure 2-3). Portions of the plan area also lie within small parts of three additional subbasins: Tracy, Chowchilla, and Delta-Mendota (Figure 2-3). Groundwater extracted from these subbasins provides water for agricultural and municipal uses. Many San Joaquin Valley cities rely either wholly or partially on groundwater to meet municipal needs. Groundwater levels in the San Joaquin Valley Groundwater Basin have generally declined as a result of extensive agricultural pumping—by as much as 100 ft in some areas, primarily in the southern and western-most portions of the basin (USGS 1999). Groundwater pumping in the region continues to increase in response to growing urban and reduced surface water deliveries from north of the Delta.

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[6] DWR's Bulletin 118 series of reports summarize and evaluate California groundwater resources.

Groundwater quality varies throughout the San Joaquin Valley Groundwater Basin and its subbasins. Variation in groundwater quality is attributed to the composition of the subsurface and the quality of the surface water infiltrating into the aquifer. Adverse water quality conditions—caused by naturally occurring constituents, as well as by agricultural and industrial contaminants—can affect the beneficial uses of groundwater. Salinity is one of the primary water quality issues, particularly in the western portion of the basin.

The Eastern San Joaquin, Modesto, Turlock, and Merced[7] Subbasins are further described, along with a summary of agricultural and municipal uses, in Sections 2.8.1 through 2.8.4, respectively. Additional information and the evaluation of groundwater impacts are provided in Chapter 9, *Groundwater Resources*.

2.1.4 Water Supply and Use

Surface Water

Several irrigation and water districts hold pre-1914 and/or appropriative water rights or contracts to divert surface waters from each of the three LSJR tributaries. These districts provide primarily agricultural supply and, in some limited cases through existing agreements, local municipal supply. Some of these districts also provide power to their service areas from hydropower generated by the rim dams. These dams also provide flood control, recreation, and other uses. Property owners with riparian water rights also divert surface water from the LSJR tributaries, primarily for agricultural uses. A summary of the irrigation district and riparian diversions from the LSJR tributaries is presented in Table 2-3, and Figure 2-4 shows the service areas of the irrigation and water districts. The information in Table 2-3 is from the irrigation districts' most recent agricultural water management plans (AWMPs) or water management plans. This information is provided to illustrate surface water diversions based on published irrigation district data. It is possible that surface water diversions may have been higher in the past, at levels not reflected by the numbers in the table, depending on the time frames and available data reported in the agricultural water management plans. The general description of various water rights in this chapter, and other chapters of this SED, are for informational purposes only, and do not constitute any confirmation by the State Water Board of the validity of any given water right claim. A more detailed description of the major irrigation districts is presented in Sections 2.3.2, 2.4.2, and 2.5.2 for diversions from the Merced, Tuolumne, and Stanislaus Rivers, respectively.

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[7] As described in Chapter 9, *Groundwater Resources*, the Merced Subbasin was extended for the analysis to include a part of the Chowchilla Subbasin.

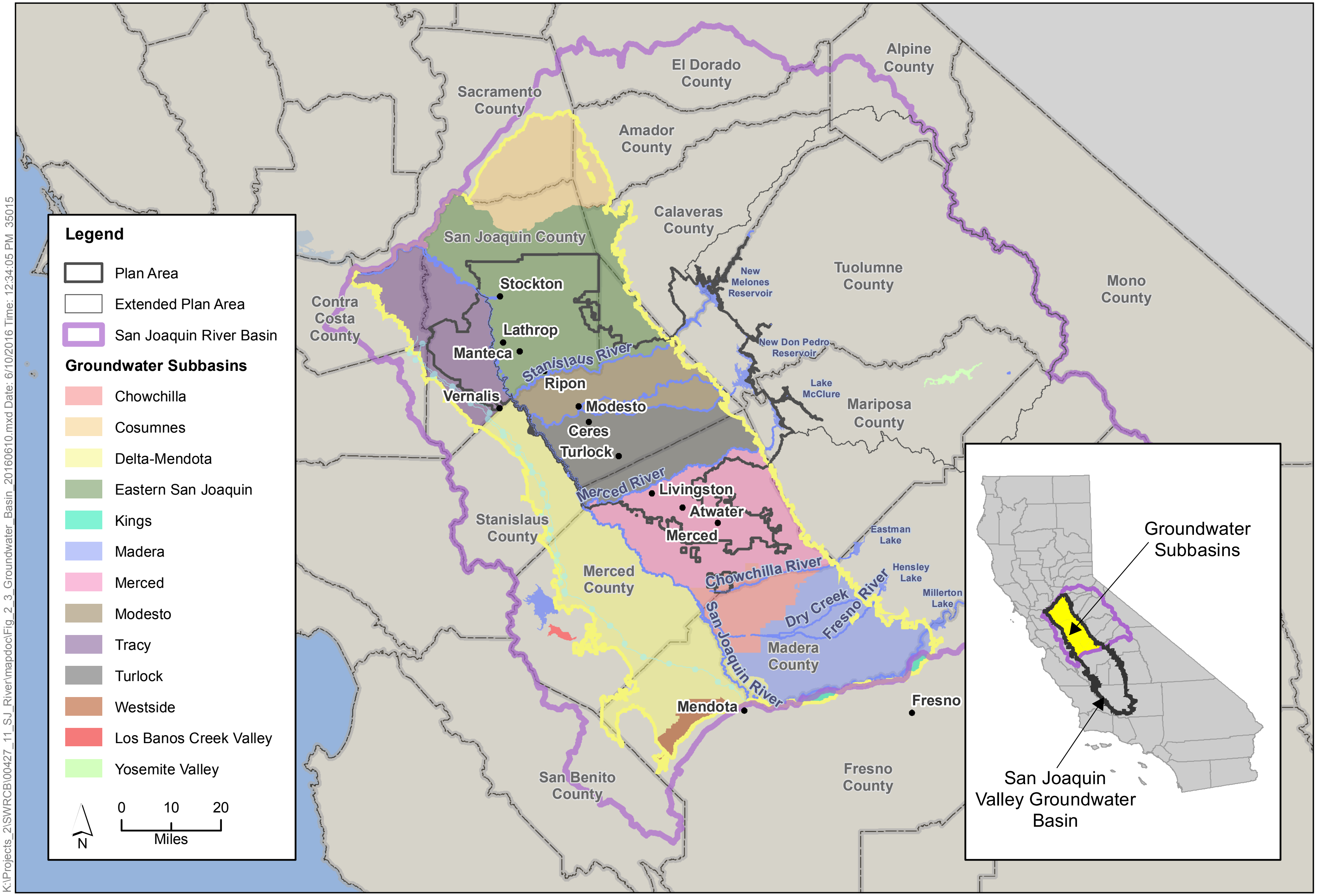

Figure 2-3
San Joaquin River Basin and Groundwater Subbasins

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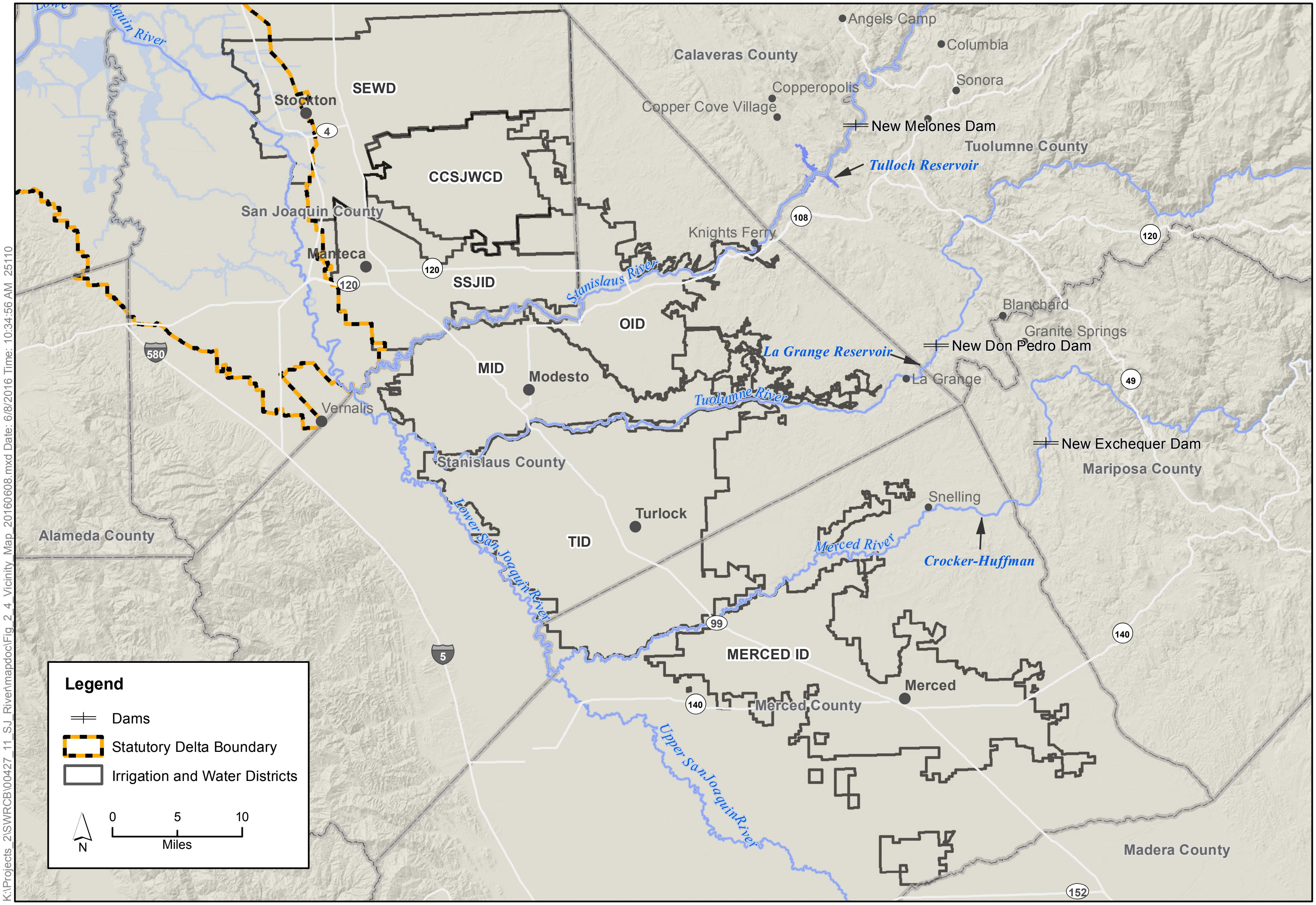

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Figure 2-4
Vicinity Map of Irrigation Districts

A representation of the water balance associated with the surface water diversions is shown in Figure 2-5. Diverted water is delivered separately to riparian diverters and irrigation districts. Riparian diverters directly deliver water for crop irrigation. Irrigation districts deliver water to a distribution system that may deliver water to a municipal water system that is separate from the delivery system for crop irrigation. Water delivery to crops is defined as applied surface water. Consumptive Use of Applied Water (CUAW) accounts for water losses due to crop irrigation. CUAW is generally defined in this analysis as irrigation water consumed by crops (not returned to the system), and it includes evaporation. Water losses separate from CUAW include deep percolation from agricultural fields, recharge and system seepage, and surface water returns. To promote water use efficiency, irrigation districts engage in conjunctive use of groundwater to supplement surface water deliveries and in-lieu recharge practices in years of adequate surface water supplies. These practices are intended to provide a net input to the groundwater over the long term.

Table 2-3. Summary of Major LSJR Surface Water Diverters and Surface Water Diversions as Reported by Irrigation District Agricultural Water Management Plans

River	Rim Dam	Surface Water Diverters	Surface Diversion Water (AF/y)[a]	Surface Water Users [b]
Stanislaus	New Melones	South San Joaquin Irrigation District (SSJID)	259,165 [c]	SSJID City of Lathrop City of Manteca City of Tracy City of Ripon SEWD
		Oakdale Irrigation District (OID)	261,896 [d]	OID SEWD
		Stockton East Water District (SEWD)	118,216 [e]	City of Stockton CalWater San Joaquin County
		Central San Joaquin Water Conservation District (CSJWCD)	32,000 [f]	CSJWCD
Tuolumne	New Don Pedro	Turlock Irrigation District (TID)	537,685 [g]	TID
		Modesto Irrigation District (MID)	315,912 [h]	MID City of Modesto
Merced	New Exchequer	Merced Irrigation District (Merced ID)	484,759 [i]	Merced ID City of Merced Stevinson Water District

River	Rim Dam	Surface Water Diverters	Surface Diversion Water (AF/y)[a]	Surface Water Users [b]

[a] These are assumed maximum diversions based on a review of published data by irrigation districts. The recent documents contain diversion values for multiple years; the year with the maximum value was selected for this table. Because the published data do not necessarily represent a lengthy time series (i.e., many years over the past 82 years), surface water diversions could be greater for these various surface water diverters than are reported in this table.

[b] Surface water users include those entities with rights to divert surface water released from the rim dams as well as those entities that have contracts to receive surface water. In some cases the diverters and the users are the same; in other cases, the diverters provide surface water to additional users.

[c] SSJID 2012. (maximum diversions from Joint Supply Canal [Table 5-13 value for 2004] and maximum direct diversions from Main Canal [Table 5-15 value for 2008]).

[d] OID 2012. (system inflows for 2007 in Table 5-13).

[e] SEWD 2014. (Table 1, surface water supply in 2010).

[f] CSJWCD 2013 (Stanislaus River surface water use in 2009).

[g] TID 2012. (Table 3.3, surface water supply in 2011).

[h] MID 2012a. (Table 30, diverted water for 2011).

[i] Merced ID 2013. (Table C-3, diverted water for 2006).

Groundwater

Figure 2-6 illustrates a conceptual representation of municipal and agricultural groundwater usage. Many San Joaquin Valley cities rely either wholly or partially on groundwater to meet municipal needs (DWR 2003a). Some agricultural and municipal uses are supplied only by groundwater pumping within the plan area. Additionally, applied groundwater is pumped by private users—those outside of irrigation district jurisdiction yet within the same groundwater basin. Generally, little information is available regarding irrigated acres and crop types for areas outside the irrigation districts irrigated primarily by groundwater.

2.2 Upper San Joaquin River

2.2.1 Basin Overview

The Upper SJR is the river south (upstream) of the confluence of the Merced River and the LSJR and includes the north, middle, and south forks.[8] The forks converge upstream of Mammoth Pool Reservoir and are impounded at the uppermost region of the valley floor by Friant Dam, approximately 25 miles northeast of Fresno—the location for measuring the unimpaired flow from the Upper SJR Watershed.[9] As identified in Table 2-1, the Upper SJR above Friant Dam drains an area of approximately 1,676 square miles with an annual average unimpaired runoff of 1.7 MAF. While the Upper SJR Watershed is outside the plan area, it is

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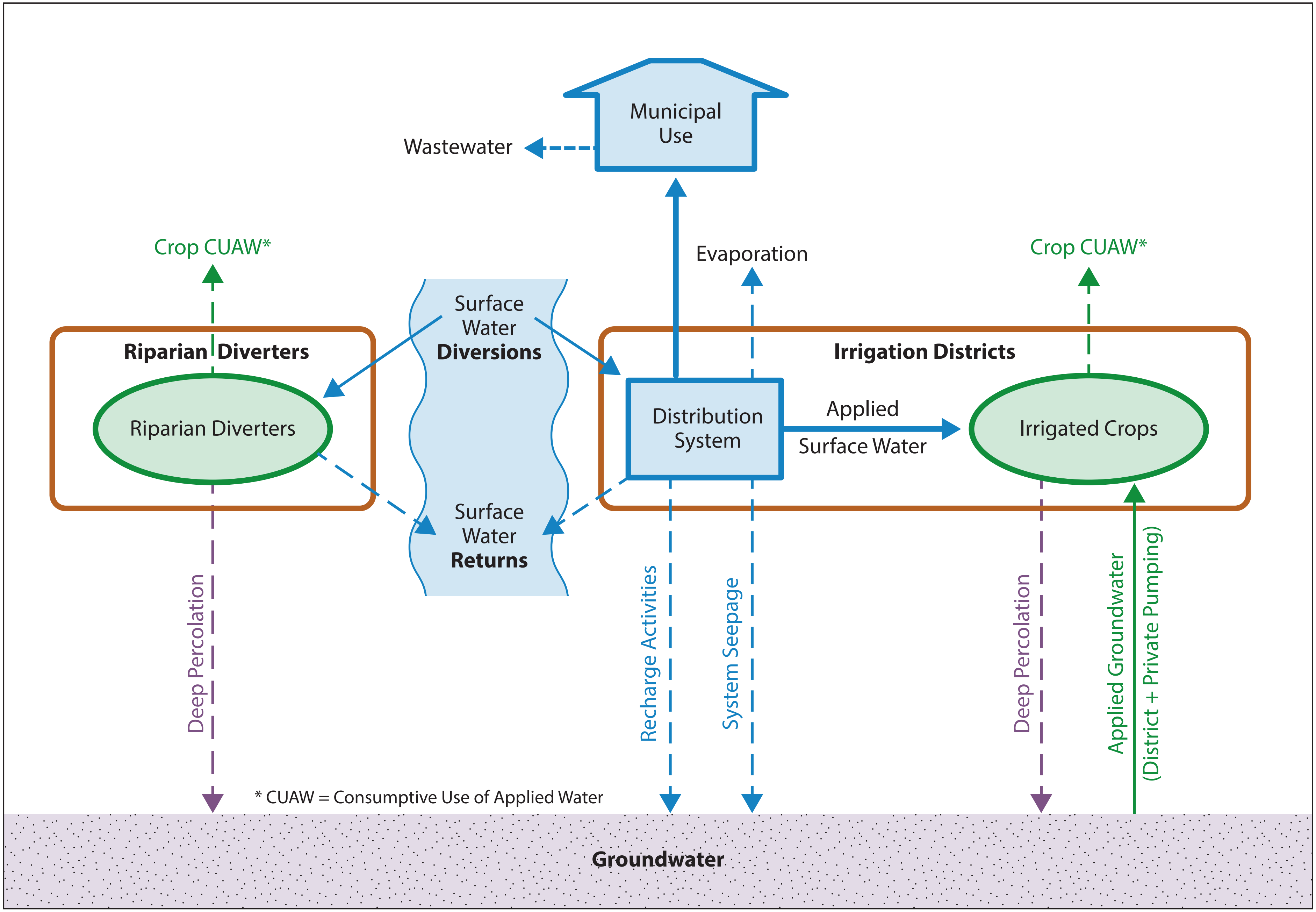
[8] The SJR Restoration Program defines the Middle SJR as the region between Friant Dam and the Merced River. There is very little runoff from the middle SJR as the Fresno and Chowchilla Rivers are the only two tributaries in this part of the river.

[9] Most of the information in Sections 2.2 through 2.6 is based on several reports including USBR 2008, EA EST 1999, and State Water Board 1999. Throughout this chapter, if no citation is given, the information was taken from one or a combination of these reports.



* CUAW = Consumptive Use of Applied Water

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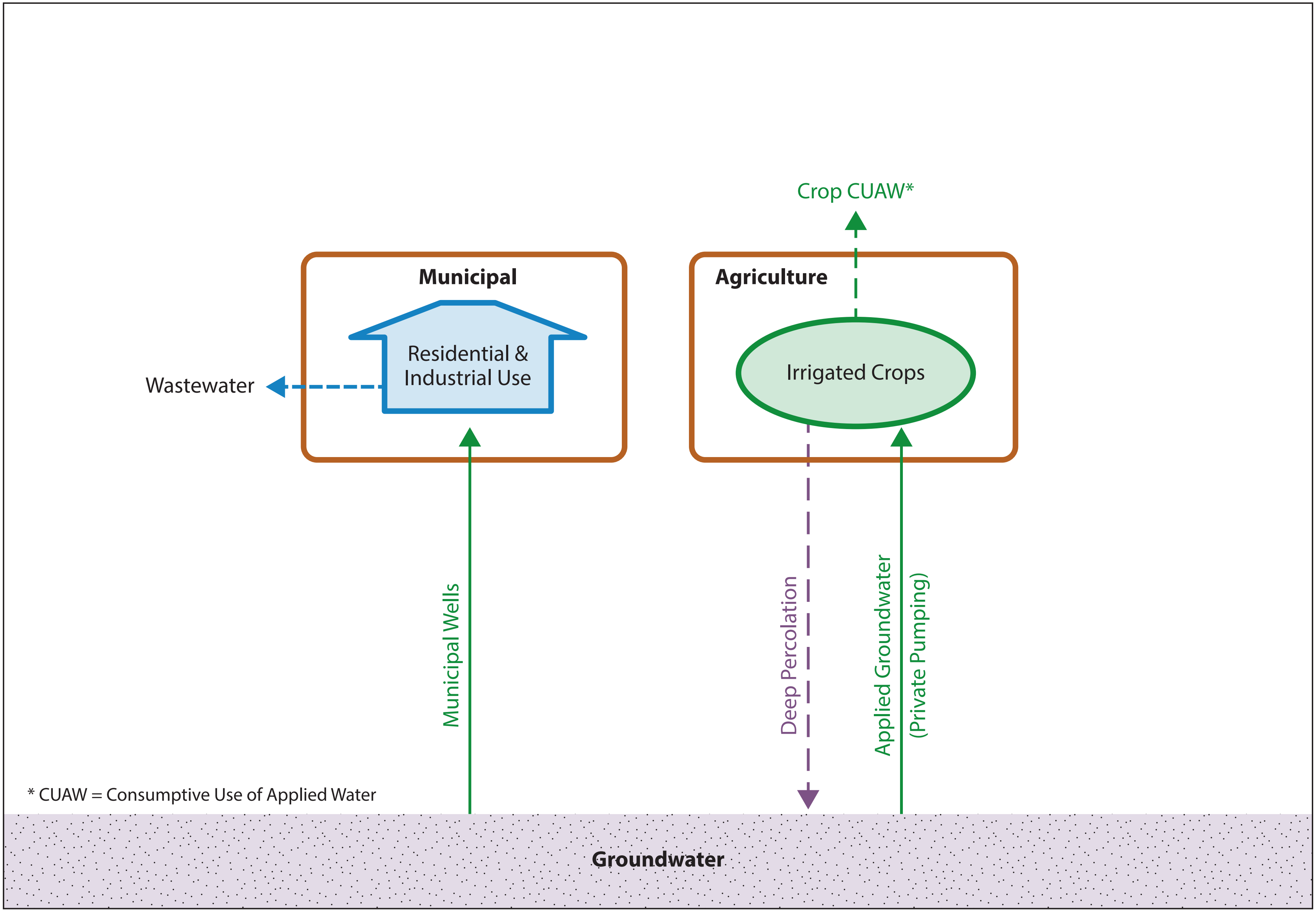
Figure 2-5
Schematic Representation of Water Use
by Irrigation Districts and Riparian Diverters



* CUAW = Consumptive Use of Applied Water

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Figure 2-6
Schematic Representation of Groundwater Pumping with Associated Consumptive Use and Returns

drained by the SJR and abuts the plan area at the Merced River confluence; accordingly, it is included in the description below.

Several dams and reservoirs on the Upper SJR are primarily used for seasonal storage for hydroelectric power generation. These dams and reservoirs—Edison, Florence, Huntington, Mammoth Pool, and Shaver Lakes—are upstream of Friant Dam. Friant Dam, completed in 1942 and placed into full operation (with canal diversions) in 1951, has a capacity of 520 thousand acre-feet (TAF) and provides flood control, releases for senior water rights diversions, and diversions into the Madera and Friant-Kern Canals (discussed below). Friant Dam forms Millerton Lake; upstream reservoir operations affect inflows to Millerton Lake. Flood control storage space in Millerton Lake is limited, and additional flood control is provided by the upstream reservoirs.

2.2.2 Water Diversion and Use

The Friant Water Authority delivers water to more than a million acres of agricultural land in Fresno, Kern, Madera, and Tulare Counties in the San Joaquin Valley. Two major canal systems divert water from Friant Dam and deliver it via the 152-mile Friant-Kern Canal south into the Tulare Lake Basin and via the 36-mile Madera Canal north to the Madera and Chowchilla Irrigation Districts. The average annual water diversion at Friant Dam is approximately 1.1 MAF. Under their water contracts, irrigation districts receive Class I (reliable) and Class II (less dependable) deliveries, as well as surplus water during flood control operations.

2.2.3 Flow Requirements

Two requirements for flow are in effect below Friant Dam, primarily to convey irrigation water to downstream diversion points: (1) a minimum of 5 cfs to bypass the last water right diversion about 40 miles downstream near Gravelly Ford, and (2) a maximum river release of approximately 125 cfs in the summer months to supply downstream riparian and water rights users. These flows generally do not make it past the Mendota Pool on the Upper SJR; consequently, water released from Friant Dam often does not reach the LSJR and Merced River confluence. The U.S. Bureau of Reclamation (USBR) is undertaking an SJR Restoration Program[10] that would provide water throughout the year to reconnect the river upstream of Friant Dam to the Upper SJR at the mouth of the Merced River. In 2006, parties to federal lawsuit *NRDC v. Rodgers* executed a stipulation of settlement that calls for, among other things, restoration of flows on the Upper SJR from Friant Dam to the confluence of the LSJR with the Merced River. Required release flows from Friant Dam for each water year type have been identified, but the amount of this Upper SJR water observed at the mouth of the Merced River is uncertain.[11]

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[10] Implementation of the settlement and the Friant Dam release flows required by the SJR Restoration Program are not part of the alternatives described in Chapter 3, *Alternatives Description*. The State Water Board expects the SJR Restoration Program would increase the existing SJR flows at Stevinson (the existing flows are currently simulated in CALSIM).

[11] In 2006, a settlement was reached in *Natural Resources Defense Council et al. v. Rodgers et al.*, and the San Joaquin River Restoration Settlement Act (Settlement Act), Public Law No. 111-11, Section 1001 et seq., 123 Stat. 991, 1349 was established. The settlement addressed restoration of fish habitat in the SJR below Friant Dam and ended an 18-year legal dispute over the operation of Friant Dam. The San Joaquin River Restoration Program was established to implement the settlement.

2.2.4 Hydrology

The average annual unimpaired flow for the Upper SJR at Friant Dam from 1984 through 2009 was 1,702 TAF. This represents approximately 28 percent of the unimpaired flow on the SJR at Vernalis. Most of this water is seasonally stored in upstream reservoirs and in Millerton Lake and diverted to the Friant-Kern and Madera Canals for irrigation. Historically, during high flow years, there are considerable flood control releases from Friant Dam. The historical monthly flows on the Upper SJR at Friant Dam were less than 125 cfs in all months, except when releases were made for flood control purposes. From 1984 through 2009, Friant Dam releases averaged 420 TAF per year (TAF/y), or approximately 25 percent of the unimpaired flow.

As an example of these historical releases, Figure 2-7 shows the monthly unimpaired flow and the historical flow below Friant Dam for the recent 10-year period of water years 2000 through 2009.[12] The average Friant Dam release for this period was approximately 20 percent of the unimpaired flow. Often, however, releases were less than 20 percent of the unimpaired flow, with flood control releases providing the majority of the flow below Friant Dam.

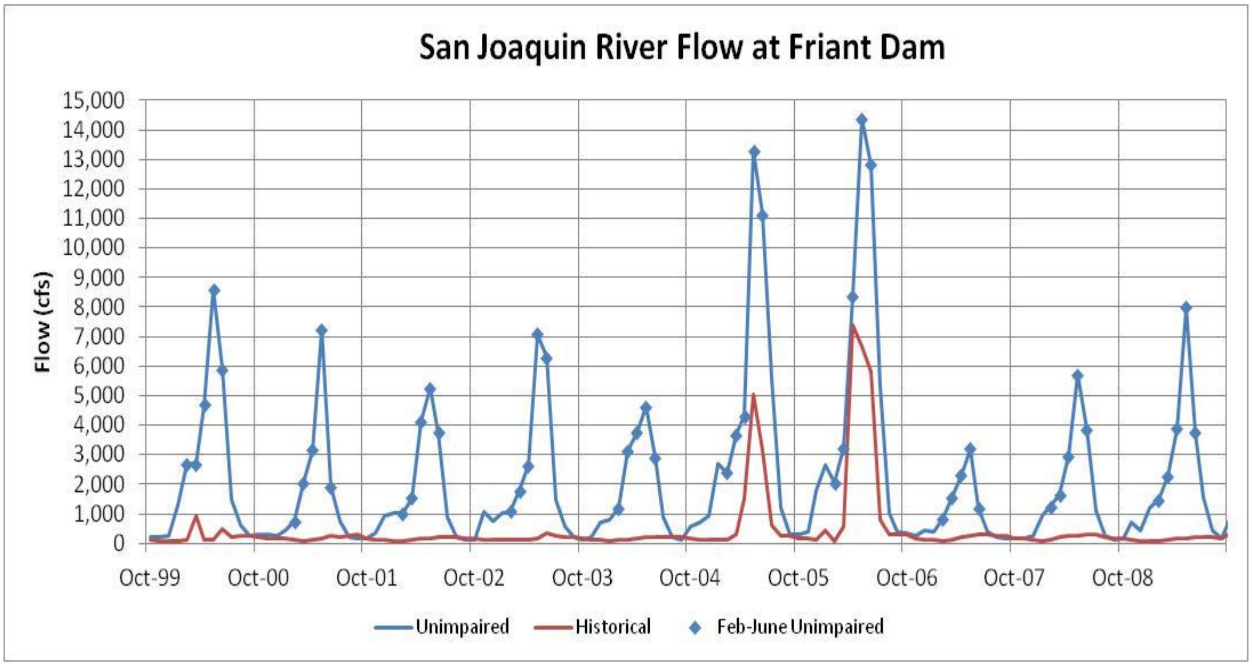

Figure 2-7. Monthly Unimpaired and Historical San Joaquin River Flows at Friant Dam for Water Years 2000–2009 (cfs = cubic feet per second)

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[12] A water year begins in October of the previous year. For example, water year 2000 begins in October, 1999.

2.3 Merced River

2.3.1 Basin Overview

As shown in Table 2-1, the Merced River is 135 miles long and drains a 1,270-square-mile watershed. The Merced River originates high in the Sierra Nevada and flows into the LSJR approximately 35 miles upstream of the Tuolumne River confluence. Approximately 52 miles of the Merced River are downstream of Crocker Huffman Dam, the most downstream barrier to fish migration. Like the Stanislaus and Tuolumne Rivers, reservoir operations have increased average monthly flows during late summer and early fall and reduced the average monthly flows during the remainder of the year (Stillwater Sciences 2001a).

Four mainstem dams and eight Division of Safety of Dams (DSOD) dams on the Merced River regulate flow conditions. The four mainstem dams, which are known collectively as the Merced River Development Project, are owned by Merced ID and licensed by the Federal Energy Regulatory Commission (FERC). New Exchequer Dam and McSwain Dam, a regulating dam downstream of New Exchequer, are the largest of the four mainstem dams; Merced Falls Dam and Crocker-Huffman Dam are the smallest. Tributaries of the Merced River upstream of New Exchequer Dam are regulated by three small dams MacMahon, Green Valley, and Metzger (Stillwater Sciences 2001b). New Exchequer Dam is the largest dam on the Merced River. It creates Lake McClure, which has a capacity of approximately 1 MAF and regulates releases to the Merced River. The New Exchequer powerhouse has a capacity of approximately 95 megawatts (MW) with a maximum flow of approximately 3,200 cfs. Water released for peaking power is regulated at the approximately 10 TAF McSwain Reservoir.

2.3.2 Water Diversion and Use

Water is withdrawn from the Merced River and used at numerous locations and by many users, including the Cowell Agreement Diverters and Merced ID, both discussed below. In the entire Merced River Watershed there are 105 post-1914 appropriative water rights, with a combined face value of approximately 5.5 MAF. Of these 105 rights, 101 are non-power water rights with a face value of approximately 1.04 MAF. Of the 101 rights, three are non-power water rights held by the Merced ID. The face value[13] of these three water rights totals approximately 1.01 MAF, accounting for approximately 98 percent of the water authorized for diversion (based on face value) under non-power water rights in the Merced River Watershed.

Cowell Agreement Diverters

The downstream Merced River diverters of water released from storage from Lake McClure are known as the Cowell Agreement Diverters (CAD). The Cowell Agreement was established on January 17, 1926, in an effort to supply riparian diverters and pre-1914 claims of water rights with releases from Lake McClure. The Merced Superior Court Order stipulates a scheduled quantity of

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[13] The *face value* of a water right refers to the maximum amount of water the right authorizes for diversion. Typically the amount diverted is less.

flow rates in the Merced River to be maintained by the Merced ID and measured at Crocker-Huffman Dam (State Water Board 2007).

The Agreement requires the Merced ID to bypass and release water in the summer so that the riparian and pre-1914 downstream users experience the same hydrologic conditions that were in place prior to the construction of the New Exchequer Dam (State Water Board 2007).

The water diverted under the Cowell Agreement is used on acreage outside the Merced ID service area. The ID has at times been required to supplement downstream flows in the Merced River with releases from storage when inflow to Lake McClure has been insufficient to satisfy the flow requirements downstream of the Crocker-Huffman Dam (State Water Board 2007).

Merced Irrigation District

Merced ID provides water and electric service to approximately 164,000 acres in the Central Valley in portions of Merced County (Merced ID 2008a), using primarily surface water diversions from the Merced River to supply irrigation water to its service area. The ID diverts approximately 100 cfs from the Merced Falls reservoir via the Northside Canal, serving roughly 10,000 acres of farmland. Merced ID diverts up to another 2,000 cfs of water from the Merced River via the Main Canal at the Crocker-Huffman Dam primarily for agricultural purposes (Merced ID 2008b). These diversions are approximately 500,000 AF/y (MAGPI 2008). In conjunction with the surface water diversions from the Merced River, Merced ID owns, operates, and maintains 239 deep irrigation wells, of which 170 wells are currently active (Merced ID 2008b). These deep irrigation wells have historically produced a maximum of 182,900 AF/y. The amount of water diverted from the Merced River and pumped from groundwater varies from year to year, so not all estimates of these volumes are the same.

Table 2-4 presents a summary of Merced ID water supply and use values from the most recent AWMP. This plan was prepared by the ID as required by Senate Bill X7-7, which was adopted by California in 2009. The AWMP does not provide one summary table for all the values incorporated in Table 2-4; rather it presents a wide array of values over multiple years or different time frames. Because the values represent different time frames there may be inherent inconsistencies between the reported values in Table 2-4. This information is presented to illustrate estimated water supply and use of surface water diversions based on published irrigation district data.

Table 2-4. Merced Irrigation District—Water Supply and Use

Water Supply/Use	Amount (thousand acre-feet)
Surface water diversions[a]	445.6
Irrigated acres[a]	100,237
Applied water[b]	279.3
CUAW (surface water & groundwater)[b]	237.8
Pumped groundwater—district[c]	7.6
Pumped groundwater—private[c]	44.1
Deep percolation of applied water[b]	60.1
Groundwater recharge from precipitation[b]	42.8
Canal system seepage[c]	103.0

Source: Merced ID 2013.

CUAW = Consumptive Use of Applied Water

[a] Reported as 2000–2008 average.

[b] Reported as 2000–2003 average.

[c] Reported as 1995–2008 average.

Merced ID generates electricity at New Exchequer Dam and McSwain Dam and sells it to utility companies (Merced ID 2008c). It also provides electric services to customers in eastern Merced County, including the Cities of Livingston, Atwater, and Merced, and to the Castle Airport and Aviation Development Center (Merced ID 2008c).

2.3.3 Flow Requirements

Flows released from the Crocker-Huffman Dam to the Merced River must satisfy FERC requirements, a Davis-Grunsky Contract between the State of California and Merced ID, and the Cowell Agreement. Flood control release limits are established by the U.S. Army Corps of Engineers (USACE) such that the combination of Dry Creek and Merced River flows must not exceed 6,000 cfs.

Merced ID holds the initial FERC license (Project Number 2179) for the Merced River Hydroelectric Project, issued on April 18, 1964. As shown in Table 2-5, FERC Project Number 2179 requires the licensee to provide minimum streamflows in the Merced River downstream from the project reservoirs.

Table 2-5. FERC Project Number 2179 Streamflow Requirements for the Merced River (cfs)

Period	Normal Year	Dry Year
June 1–October 15	25	15
October 16–October 31	75	60
November 1–December 31	100–200	75–150
January 1–May 31	75	60

FERC Project Number 2179 also requires that during the period November 1–December 31, the Merced River streamflow downstream from McSwain Dam be regulated between 100 and 200 cfs, except during dry years when the streamflow should be maintained between 75 and 150 cfs. Streamflows are measured at Shaffer Bridge on the Merced River downstream of McSwain Dam. These flows are required during the fall-run Chinook salmon egg incubation period to prevent redd scouring or dewatering. The Project is currently undergoing relicensing with the Commission, and a Section 401 water quality certification issued by the State Water Board is required. (33 U.S.C. § 1341.)

In 1967, Merced ID executed a Davis-Grunsky Contract with the California Department of Fish and Wildlife (CDFW, formerly the California Department of Fish and Game). The contract provides minimum flow standards that require flows no less than 180–220 cfs to be maintained between November and March from Crocker-Huffman Dam to Shaffer Bridge.

The Cowell Agreement, between Merced ID and the Cowell Agreement Diverters, calls for flows downstream of the Crocker-Huffman Dam to meet the water rights of other diverters. The Cowell Agreement Diverters are downstream riparian and pre-1914 water users. This water can then be diverted from the river at a number of private ditches between Crocker-Huffman Dam and Shaffer Bridge. The minimum flow requirements are provided in Table 2-6.

Table 2-6. Cowell Agreement Streamflow Requirements for the Merced River (cubic feet per second)

Month	Flow
October 1–15	50
October 16–31	50
November–February	50
March	100
April	175
May	225
June	250
July	225
August	175
September	150

2.3.4 Hydrology

The unimpaired flow of the Merced River is the flow that would occur without existing diversions. The historical flow of the Merced River is influenced by the operation of the existing dams and diversions. The hydrographs in Figure 2-8 depict both types of flows and show the monthly unimpaired historical flow below Crocker-Huffman Dam for the recent 10-year period of water years 2000 through 2009. During this period, the unimpaired flow at New Exchequer Dam averaged 884 TAF/y and the historical releases (including flood flows in 2000, 2005, and 2006) averaged 403 TAF/y.

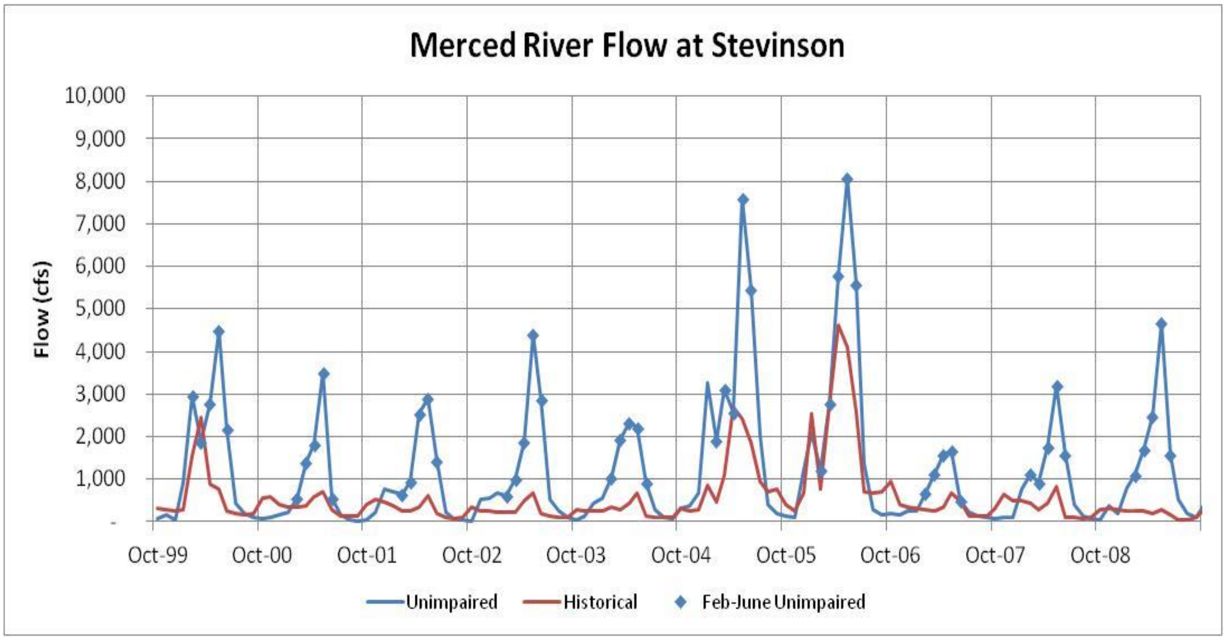

Figure 2-8. Monthly Unimpaired and Historical Merced River Flows February–June for Water Years 2000–2009 (cfs = cubic feet per second)

The Crocker-Huffman Dam releases averaged approximately 45 percent of the unimpaired flow, but the releases were usually less than 40 percent of the unimpaired flow, with flood control releases providing the majority of the flow below Crocker-Huffman Dam. The historical monthly flows at Stevinson (near the mouth of the Merced) are generally lower than the unimpaired flows in the winter and spring months, and often slightly higher than the unimpaired flows in the fall months. Table 2-7 summarizes the range of historical and unimpaired flows on the Merced River February–June. The peak historical flows were in April and May 2006 because Lake McClure was nearly full, and the relatively high flow of 4,500 cfs was for flood control purposes.

Table 2-7. Historical and Unimpaired Flow February–June on the Merced River (cubic feet per second)

Water Year	Historical (observed) Range	Unimpaired Range
2000	250–2,500	2,000–4,500
2001	250–750	500–3,500
2002	250–500	750–3,000
2003	250–750	500–4,500
2004	250–750	1,000–2,250
2005[a]	750–2,500	2,000–7,500
2006[a]	1,000–4,500	1,000–8,000
2007	250–750	750–1,750
2008	250–750	1,000–3,000
2009	250	1,000–5,000

[a] The high historical flows in 2005 and 2006 were because Lake McClure was nearly full, and releases for flood control purposes were made in each of these years.

The Merced River monthly unimpaired flows (at New Exchequer Dam) are summarized in Table 2-8, with the cumulative distributions of unimpaired flow (in 10 percent increments) for each month from 1984 to 2009. Each month has a range of runoff depending on the rainfall and accumulated snowpack. The median flows (50 percent cumulative) can be used to characterize generally the seasonal runoff pattern. The peak runoff for the Merced River is observed in May and highest runoff (median monthly runoff greater than 90 TAF, or 1,500 cfs) is observed March–June. The minimum flows are observed in August, September, October, and November. The distribution of annual unimpaired flow ranged from 410 TAF (10th percentile) to 1,746 TAF (90th percentile), with a median runoff of 721 TAF. The average unimpaired flow was 884 TAF/y, 23 percent more than the median runoff, representing approximately 15 percent of the unimpaired flow at Vernalis.

Table 2-9 provides a monthly summary of the historical flows observed at Stevinson. The Merced River flows are subject to minimum flow requirements, as described above. The majority of the historical monthly flows were between 5 TAF and 30 TAF (75 cfs and 500 cfs). The annual river flow volume ranged from 102 TAF (10th percentile) to 1,167 TAF (90th percentile). The median historical annual river flow was 398 TAF. The average historical flow was 452 TAF/y for these years, 14 percent higher than the median. The average historical flow was approximately 48 percent of the average unimpaired flow, but the majority of the flow occurred in the wet years due to flood control releases. Lake McClure is the smallest of the three eastside tributary reservoirs and is generally filled and drawn down each year. Nevertheless, flood control releases are not necessary each year; consequently, it is difficult to anticipate when reservoir releases for flood control storage will be required.

Table 2-8. Monthly and Annual Unimpaired Flow in the Merced River 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	2	5	6	11	22	50	93	104	32	11	4	1	410
20	2	6	8	13	28	56	104	117	48	13	5	2	450
30	3	7	10	18	34	61	113	153	56	18	6	3	548
40	4	9	13	35	37	69	129	184	85	25	7	4	608
50	5	11	19	45	60	96	143	233	104	31	9	5	721
60	7	13	25	49	68	105	151	270	130	33	11	6	906
70	10	18	29	62	91	118	163	280	156	42	13	6	1,195
80	13	22	34	103	105	161	181	316	228	51	15	7	1,559
90	16	30	61	195	181	181	199	386	328	110	23	10	1,746

Note: The cumulative distribution indicates the probability of occurrence for the variable. For example, a 10th value of 2 indicates that 10 percent of the time, the value would be expected to be less than 2. This term is not referring to, and should not be confused with, the term cumulative impacts, which is a specific CEQA term. A discussion of cumulative impacts for CEQA purposes is provided in Chapter 4, *Introduction to Analysis*, and Chapter 17, *Cumulative Impacts, Growth-Inducting Effects, and Irreversible Commitment of Resources*.

Table 2-9. Monthly and Annual Historical Flow in the Merced River 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	5	11	12	13	12	15	10	9	6	2	2	3	102
20	11	14	13	14	14	15	11	12	8	4	4	5	148
30	17	15	14	15	15	17	19	21	10	6	6	6	193
40	19	15	15	16	18	18	22	39	11	8	6	7	224
50	20	15	16	20	18	20	27	41	13	9	8	8	271
60	25	17	19	30	21	24	34	44	16	11	9	11	363
70	28	21	25	36	26	59	56	52	23	15	11	13	550
80	34	31	30	47	71	144	66	82	35	19	17	19	764
90	67	36	57	104	90	168	169	160	127	50	39	43	1,167

2.4 Tuolumne River

2.4.1 Basin Overview

As shown in Table 2-1, the Tuolumne River is approximately 155 miles long and drains an area of approximately 1,900 square miles. The Tuolumne River originates in the high elevations of the Sierra Nevada and flows into the LSJR approximately 8 miles upstream of the Stanislaus River confluence. Like the other two eastside tributaries of the LSJR, the Tuolumne River receives most of its flow from late spring and early summer snowmelt; however, peak flows generally occur during winter rain events.

Existing dams, water diversions, and downstream minimum flow agreements influence the hydrology of the Tuolumne River. New Don Pedro Dam, the major dam on the Tuolumne River, provides water to the Turlock Irrigation District (TID) and Modesto Irrigation District (MID). The dams constructed on tributaries in the upper Tuolumne River Watershed provide hydropower and water supply for the City and County of San Francisco (CCSF). CCSF operates several water supply and hydroelectric facilities in the upper reaches of the Tuolumne above New Don Pedro Dam. O’Shaughnessy Dam on the mainstem Tuolumne River impounds approximately 360 TAF in the Hetch Hetchy Reservoir to address CCSF’s water needs of and to provide instream flows in the Tuolumne River below O’Shaughnessy Dam. Two other storage facilities upstream of New Don Pedro Reservoir, Lake Eleanor and Cherry Lake, are also operated by CCSF for hydropower and water supply purposes. The combined capacity of these two reservoirs is approximately 300 TAF. Water from Lake Eleanor is diverted through the Lake Eleanor Diversion Tunnel and into Cherry Lake where it is released to supplement flows of the upper Tuolumne River. The Hetch-Hetchy aqueduct conveys water from the Tuolumne River to the CCSF service area; the physical capacity of approximately 500 cfs is limited by the Coastal Tunnel.

New Don Pedro Dam, the major dam on the Tuolumne River, was constructed in 1971 to replace the original Don Pedro Dam. The hydroelectric power plant with four units has a combined capacity of 203 MW, with a maximum flow of 5,500 cfs. Flows in the lower portion of the Tuolumne River are controlled primarily by operation of New Don Pedro Dam. The 2 MAF reservoir stores water for irrigation, hydroelectric generation, fish and wildlife enhancement, recreation, and flood control purposes (340,000 AF for flood control). Water released from the New Don Pedro Dam is regulated at LaGrange Dam and Reservoir. La Grange Dam, 2.5 miles downstream of New Don Pedro Dam, is the diversion point for the TID and Merced ID canals.

2.4.2 Water Diversion and Use

Water is withdrawn from the Tuolumne River and used at numerous locations and by many users, including TID, MID, and CCSF, discussed below. In the Tuolumne River Watershed there are 165 post-1914 appropriative water rights with a combined face value of approximately 7.2 MAF. Of these 165 rights, 160 are non-power water rights with a face value of approximately 2.65 MAF. Of the 160 rights, 5 are non-power water rights held by TID and MID. The face value of these five water rights totals approximately 2.62 MAF, accounting for approximately 99 percent of the water authorized for diversion (based on face value) under non-power water rights in the Tuolumne River Watershed (State Water Board 2015).

The amount and uses of water actually diverted vary. On average, more than 60 percent of the annual flow of the Tuolumne River is diverted for agricultural or municipal and industrial use by TID and MID. Each year, approximately 575 TAF of water is diverted to TID's canal into Turlock Lake and 310 TAF is diverted to MID's canal into the Modesto Reservoir for use in the service districts. Nearly all the diverted surface water irrigates crops in the two districts. Many of the TID and MID diversions from the Tuolumne River occur at New Don Pedro and La Grange reservoirs.

City and County of San Francisco

The current CCSF demand for water is approximately 290 TAF/y, or about 15 percent of the annual average unimpaired flow of the Tuolumne River. The water rights and operating agreement for New Don Pedro Reservoir includes seasonal storage in the CCSF upstream reservoirs and water banking (accounting) between TID, MID, and CCSF. CCSF has the right to store up to 740,000 AF/y in New Don Pedro Reservoir (CCSF, TID, and MID 1966).

Turlock Irrigation District

TID has an irrigation service area of approximately 307 square miles (196,000 acres) (TID 2013). It provides water and electric services to areas in Stanislaus and Merced Counties, as well as portions of Tuolumne and Mariposa Counties (TID 2010a, 2010b). TID uses primarily surface water diversions from the Tuolumne River and supplements them with groundwater to supply irrigation water (TID 2010c) (Table 2-10).

Table 2-10 presents a summary of TID water supply and use values from the most recent AWMP. This plan was prepared by the irrigation district as required by Senate Bill X7-7, which was adopted by California in 2009. The AWMP does not provide one summary table for all of the values incorporated in Table 2-10. Rather it presents a wide array of values over multiple years or different time frames. Because the values represent different time frames there may be inherent inconsistencies between the reported values in Table 2-10. This information is provided to illustrate estimated water supply and use of surface water diversions based on published irrigation district data.

Table 2-10. Turlock Irrigation District - Water Supply and Use

Water Supply/Use	Amount (thousand acre-feet)
Surface water supply [a]	503.6
Ground water supply [a]	100.0
Irrigated acres [b]	157,800
Agricultural water delivered [c]	499.0
Pumped groundwater— district [a]	99.8
Pumped groundwater— private [c]	19.0
Total Recharge [a]	243.2

Source: TID 2012.

[a] Reported as 1991–2011 average.

[b] Reported in 2012.

[c] Reported as 2007–2011 average.

TID provides electrical service to an area encompassing approximately 660 square miles and includes more than 98,000 accounts. TID is the majority owner and operating partner of the Don Pedro Hydroelectric Project. TID owns approximately 68 percent of the total capacity, which is approximately 139 MW of power (TID 2010b, 2010d).

Modesto Irrigation District

MID is an independent, publicly owned utility that provides water and electric services to parts of Stanislaus County, San Joaquin County and a small portion located in Calaveras County around the New Don Pedro Dam. The water service area encompasses approximately 113,000 acres (MID 2012a) (Table 2-11). MID has pre-1914 water rights to obtain surface water supply at diversion points below New Don Pedro Reservoir and La Grange Dam as described above and pumps groundwater to supplement surface water supplies for irrigation. It provides approximately 173,750 AF (20-year average) of irrigation water to approximately 58,000 irrigated acres within its service area (MID 2012b). It also provides up to 42 million gallons of drinking water to the City of Modesto per day and is expanding the Modesto Regional Water Treatment Plant to increase delivery to an average of 60 million gallons of water per day (MID 2012b, 2015).

Table 2-11 presents a summary of MID water supply and use values from the most recent AWMP. This plan was prepared by the irrigation district as required by Senate Bill X7-7, which was adopted by California in 2009. The AWMP does not provide one summary table for all the values incorporated in Table 2-11; rather it presents a wide array of values over multiple years or different time frames. Because the values represent different time frames, there may be inherent inconsistencies between the reported values in Table 2-11. This information is provided to illustrate estimated water supply and use of surface water diversions based on published irrigation district data.

Table 2-11. Modesto Irrigation District—Water Supply and Use

Water Supply/Use	Amount (thousand acre-feet)
Surface water supplies [a]	284.3
Applied surface water [a]	153.0
Irrigated acres [b]	66,517
Crop CUAW [a]	173.2
Pumped groundwater— district[a]	20.1
Municipal deliveries [a]	30.0
On farm recharge from irrigation[a]	58.1
Canal seepage [a]	8.0

Source: MID 2012a.
CUAW = Consumptive Use of Applied Water.
[a] Reported as year 2009.
[b] Reported as year 2012.

MID provides electrical service to approximately 560 square miles and more than 110,000 accounts in the following areas: the Greater Modesto Area (north of the Tuolumne River, Waterford, Salida, Mountain House [Northwest of Tracy], and parts of Ripon, Escalon, Oakdale and Riverbank). Pacific Gas and Electric Company (PG&E) also provides electric service in Riverbank, Oakdale, Ripon and Escalon in conjunction with MID. MID produces approximately 25 percent of its own electricity and purchases the remaining 75 percent (MID 2012b). MID owns approximately 64 MW of the power generated by New Don Pedro Reservoir, comprising approximately 9 percent of the power MID generates (TID 2010d; MID 2012b).

2.4.3 Flow Requirements

Flow requirements on the Tuolumne River include the original FERC license (1966) for the operation of New Don Pedro Reservoir and a 1995 settlement agreement that amended the FERC license. TID and MID jointly hold the initial FERC license (Project Number 2299) for the New Don Pedro Project. USACE also established flood control release limits. These requirements are summarized in Table 2-12.

Table 2-12. Tuolumne River Flow Requirement Summary

Requirement	Description	Parties	Releases
FERC License Project No. 2299	Provides specified releases from New Don Pedro to protect fall-run Chinook salmon spawning below La Grange Dam	TID, MID, and FERC	Annual volume for normal water years is 120 TAF; annual volume for dry water years is 65 TAF; specific flows identified during different months
Article 37 of FERC License Project No. 2299	Provides additional flows from original FERC License	CDFW, FERC, MID, and TID	Annual volume of water was increased to 95 TAF in dry water years and 300 TAF in normal water years
USACE	Establishes flood control release limits	USACE, MID, and TID	Releases are established by USACE for 12 months such that releases cannot exceed 9,000 cfs per month on Tuolumne River below Dry Creek

USBR = U.S. Bureau of Reclamation
CDFW = California Department of Fish and Wildlife
USACE = U.S. Army Corps of Engineers
FERC = Federal Energy Regulatory Commission
MID = Modesto Irrigation District
TID = Turlock Irrigation District

The original FERC license was issued on March 10, 1964; became effective on May 1, 1966; and has a term that expired April 30, 2016. The Project is currently undergoing relicensing with the Commission, and a Section 401 water quality certification issued by the State Water Board is required. (33 U.S.C. § 1341.) The FERC license is conditioned to require specified releases of water from New Don Pedro Reservoir for the protection of fall-run Chinook salmon, which spawn in the Tuolumne River below La Grange Dam. These required flows in most years (normal) were 200–400 cfs from October through March, with 100 cfs in April and 3 cfs from May through September. As shown in Table 2-13, the annual volume of required streamflows was almost 120 TAF. The dry year flows were approximately half of the normal year flows, with an annual volume of almost 65 TAF.

Table 2-13. FERC Project Number 2299 Streamflow Requirements for the Tuolumne River

Period	Normal Year (cfs)	Dry Year (cfs)
October 1–15	200	50
October 16–October 31	250	200
November	385	200
December 1–15	385	200
December 16–31	280	135
January	280	135
February	280	135
March	350	200
April	100	85
May–September	3	3
Annual (TAF)	118	64

cfs = cubic feet per second
TAF = thousand acre-feet

The settlement agreement with CDFW established in 1995 proposed that Article 37 of the FERC license be amended to increase flows released from the New Don Pedro Dam. Several different runoff conditions were associated with higher required streamflows, and the annual volume of water required for stream flows was increased from approximately 95 TAF in the driest years to a maximum of approximately 300 TAF in years with greater-than-average runoff. Pulse flows are specified for salmonid attraction in October and outmigration in April and May.

2.4.4 Hydrology

The unimpaired flow of the Tuolumne River is the flow that would occur without existing diversions. The historical flow of the Tuolumne River is influenced by the operation of the existing dams and diversions as described above. The hydrograph in Figure 2-9 depicts both types of flow over time. It shows the monthly unimpaired and historical flow below LaGrange Dam for the recent 10-year period of water years 2000 through 2009, reflects that the unimpaired flow at New Don Pedro Dam averaged 1,738 TAF/y, and that the historical releases (including flood flows in 2000, 2005, and 2006) averaged 695 TAF/y.

LaGrange Dam released an average of approximately 40 percent of the unimpaired flow, but the releases were usually much less than 40 percent of the unimpaired, with flood control releases providing most of the flow below LaGrange Dam. The historical monthly flows at Modesto (near the mouth of the Tuolumne River) were generally less than the unimpaired flows in the winter and spring months, and were often slightly higher than the unimpaired flows in the late summer and fall months.

Table 2-14 summarizes the range of historical and unimpaired flows on the Tuolumne River February–June. The peak historical flows were in April and May 2006 because New Don Pedro Reservoir was nearly full, and 8,000 cfs was released for flood control purposes.

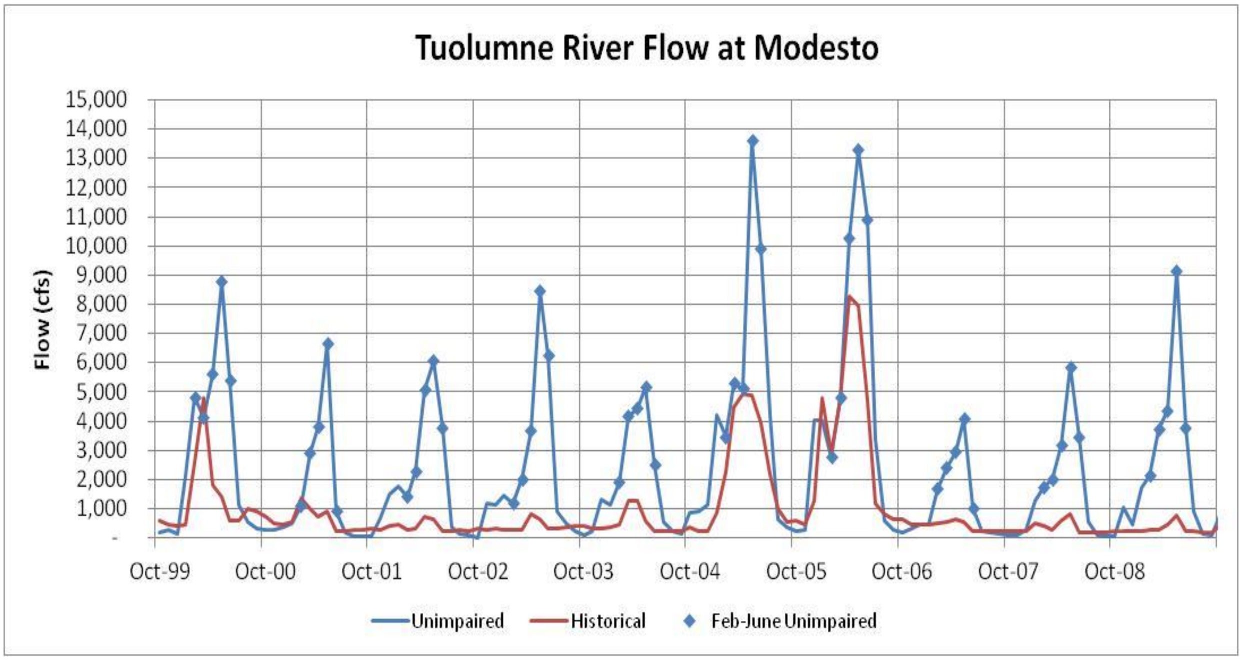

Figure 2-9. Monthly Unimpaired and Historical Tuolumne River Flows February–June for Water Years 2000–2009 (cfs = cubic feet per second)

Table 2-14. Historical and Unimpaired Flow February–June on the Tuolumne River (cubic feet per second)

Water Year	Historical Range	Unimpaired Range
2000	500–5,000	2,000–9,000
2001	250–1,000	1,000–7,000
2002	250–500	1,500–6,000
2003	250–750	1,000– 8,500
2004	250–1,250	2,000–5,000
2005[a]	2,000–5,000	3,500–13,500
2006[a]	3,000–8,000	3,000–13,000
2007	250–500	1,000–4,000
2008	250–750	2,000–6,000
2009	250–750	2,000–9,000

[a] In 2005 and 2006, the high historical flows occurred because New Don Pedro Reservoir was nearly full, and releases for flood control purposes were made in each month February–June.

The Tuolumne River monthly unimpaired flows (at New Don Pedro Dam) are summarized in Table 2-15 with the cumulative distributions of unimpaired flow (in 10 percent increments) for each month 1984–2009. Each month has a range of runoff depending on the rainfall and accumulated snowpack. The median flows (50 percent cumulative) can be used to generally characterize the seasonal runoff pattern. The peak runoff for the Tuolumne River is in May, and highest runoff (median monthly runoff greater than 180 TAF, or 3,000 cfs) is observed March–June. The minimum flows are observed in August, September, October, and November. The distribution of annual unimpaired flow ranges from 839 TAF (10th percentile) to 3,268 TAF (90th percentile), with a median runoff of 1,514 TAF. The average unimpaired flow was 1,851 TAF/y, 22 percent more than the median runoff. This represents approximately 30 percent of the unimpaired flow at Vernalis. Since 300 TAF/y are diverted upstream of New Don Pedro Reservoir, the average inflow to New Don Pedro Reservoir is approximately 85 percent of the Tuolumne River unimpaired flow.[14]

Table 2-15. Monthly and Annual Unimpaired Flow in the Tuolumne River 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	4	8	16	24	53	112	184	208	63	17	4	3	839
20	5	13	18	32	60	124	195	275	100	24	8	4	884
30	9	17	25	40	67	136	219	329	141	30	9	7	1,114
40	10	18	29	70	93	168	230	360	207	33	14	7	1,312
50	11	23	47	97	105	190	263	443	260	57	20	10	1,514
60	15	26	58	129	151	232	301	536	330	67	26	15	2,018
70	18	49	70	134	161	271	307	541	381	101	33	18	2,394
80	21	62	82	202	192	296	323	569	507	144	37	20	2,971
90	38	77	171	269	313	340	343	645	619	242	52	23	3,268

The Tuolumne River flows are subject to minimum flow requirements as described above. Table 2-16 provides a monthly summary of the historical flows in the Tuolumne River at Modesto. The majority of the historical monthly flows were between 10 TAF and 30 TAF (150 cfs and 500 cfs). The annual river flow volume ranged from 155 TAF (10th percentile) to 2,249 TAF (90th percentile). The median historical annual river flow was 398 TAF. The average historical flow was 845 TAF/y, considerably greater (112 percent) than the median. The average historical flow was approximately 46 percent of the average unimpaired flow, but most of this historical flow was observed in the wet years with flood control releases. New Don Pedro Reservoir is the second largest reservoir on the LSJR tributaries and allows considerable carryover storage from one year to the next. Therefore, flood control releases are not necessary each year; consequently, it is difficult to anticipate when reservoir releases for flood control storage will be required.

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[14] Approximately 300 TAF of the unimpaired Tuolumne River flows are diverted each year to the San Francisco Hetch Hetchy aqueduct for municipal water supply purposes.

Table 2-16. Monthly and Annual Historical Flow in the Tuolumne River 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	10	12	12	13	14	16	22	17	7	7	7	7	155
20	15	14	15	18	15	18	23	26	9	8	9	10	213
30	16	16	16	25	24	19	34	31	13	13	12	11	265
40	21	18	20	28	26	23	43	38	15	15	15	14	316
50	27	21	25	35	28	46	46	42	17	16	17	16	398
60	36	27	27	41	76	79	56	52	20	20	21	23	593
70	42	29	28	54	144	209	102	79	28	21	27	30	1,236
80	46	30	78	96	236	291	180	170	47	30	30	38	1,560
90	74	51	129	231	302	338	324	275	251	103	61	58	2,249

2.5 Stanislaus River

2.5.1 Basin Overview

As shown in Table 2-1, the Stanislaus River is approximately 161 miles long and covers an area of approximately 1,195 square miles. The Stanislaus River originates in the high elevations of the Sierra Nevada and flows into the LSJR approximately 3 miles upstream of Vernalis at Ripon. The Stanislaus River receives most of its flow from late spring and early summer snowmelt; however, peak flows generally occur during winter rain events.

The New Melones Dam, the major CVP dam on the Stanislaus River, is located just downstream of the confluence of the river's three forks. There are two smaller dams downstream of New Melones: Tulloch Dam and Goodwin Dam. Two irrigation districts, South San Joaquin Irrigation District (SSJID) and Oakdale Irrigation District (OID) divert water from the Stanislaus River and generate hydropower, which they sell to the California Independent System Operator (CalISO). One municipal water conservation district—Stockton East Water District (SEWD)—and the Central San Joaquin Water Conservation District (CSJWCD) also divert water.

The Stanislaus River has 28 dams under DSOD jurisdiction storing an approximate 2.8 MAF of water; these include the New Melones, Tulloch, and Goodwin Dams and several small dams both upstream and downstream of New Melones. The New Melones Reservoir was completed by USACE in 1979 and first filled in 1982. New Melones Reservoir is approximately 60 miles upstream of the confluence of the Stanislaus River and the LSJR and is operated by USBR. With a storage capacity of approximately 2.4 MAF, the dam has two hydroelectric generators with a combined capacity of 300 MW (USBR 2010) and a maximum flow of 8,000 cfs. Existing flow requirements in the 1987 Agreement, Decision 1422, U.S. Fish and Wildlife Service (USFWS) Anadromous Fish Restoration Program (AFRP), and National Marine Fisheries Service (NMFS) Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project (CVP) and State Water Project (SWP) (NMFS BO), specify flow releases on the Stanislaus River.

New Melones Reservoir is a component of the CVP, but it is authorized to provide water supply benefits within the defined Stanislaus River Basin per the 1980 Record of Decision (ROD) before additional water supplies can be used outside of the defined basin. New Melones Reservoir is operated for the following purposes: water supply, maximum storage for flood control and maximum releases conducted in accordance with USACE's operational guidelines, power generation, fishery enhancement, improvement of SJR water quality at Vernalis, and dissolved oxygen requirements at Ripon. The reservoir and river corridor also provide recreational benefits.

Tulloch Dam and power plant are located approximately 6 miles downstream of New Melones Dam. Tulloch dam is part of the Tri-Dam Project, which is a power generation project that consists of two additional dams, Donnells and Beardsley Dams, located upstream of New Melones Reservoir. The water released from New Melones Dam (for peaking power) is regulated by Tulloch Reservoir, which has a capacity of 67 TAF. Goodwin Dam, approximately 2 miles downstream of Tulloch Dam, was constructed by OID and SSJID in 1912. Water released from Tulloch Dam flows into Goodwin Dam, which impounds water for diversion into the irrigation canals for OID and SSJID or release to the lower Stanislaus River. Goodwin Dam also creates a reregulating reservoir for peaking power releases from Tulloch power plant. Water may also be gravity fed into the Goodwin Tunnel for deliveries to the CSJWCD and SEWD.

2.5.2 Water Diversion and Use

The Stanislaus River has many diverters that apply the water to beneficial use, including SEWD/CCSJID, SSJID, and OID, discussed below. These districts also receive water diverted and released by USBR at New Melones Reservoir. These water diverters include appropriative water rights holders, pre-1914 users, and riparian claim users. In the Stanislaus River Watershed there are 160 post-1914 appropriative water rights with a combined face value of approximately 19.7 MAF. Of these 160 water rights, 139 are non-power water rights with a face value of approximately 4.2 MAF. Of the 139 water rights, 16 are non-power water rights held by OID, SSJID, USBR, McMullin Reclamation District #2075, and River Junction Reclamation District #2064. The face value of these 16 rights totals approximately 3.9 MAF, accounting for approximately 94 percent of the water authorized for diversion (based on face value) under non-power water rights in the Stanislaus River Watershed.

SSJID and OID hold pre-1914 water rights to divert water from the Stanislaus River for use within their service districts. These districts also generate hydropower, which they sell to CalISO. Delivery of water from New Melones Reservoir to SSJID and OID is described by the 1988 agreement and stipulation with USBR, which specifies that the districts receive 600,000 AF of water when the projected flow in the Stanislaus River is greater than 600,000 AF (OID 1988). OID and SSJID generally divide the water available to them under the 1988 agreement equally, each receiving approximately 300,000 AF. OID has an adjudicated pre-1914 water right held jointly with SSJID to directly divert 1,816.6 cfs of flow from the Stanislaus River (OID 2012). The location and general characteristics of the four districts that receive water from the Stanislaus River are provided below.

South San Joaquin Irrigation District

The SSJID service area covers approximately 70,000 acres in San Joaquin County. The predominant land use in SSJID is agricultural (approximately 60,000 acres, Table 2-17); however, SSJID currently provides some surface water to cities, including Lathrop, Manteca, Tracy, and Ripon. Stanislaus River surface water is diverted into the SSJID and OID Joint Main Canal at the Goodwin Dam and is channeled into Woodward Reservoir. SSJID releases water from Woodward Reservoir into a conveyance system of canals to provide irrigation water for agricultural customers. Unused surface water drains north to the French Camp Outlet Canal. A small portion of irrigation runoff drains south as surface water return flows to the Stanislaus River. Return flows to the Stanislaus River are estimated to be approximately 3,000 AF/y based on monitored 1996 and 1997 data (EA EST 1999).

Table 2-17. South San Joaquin Irrigation District—Water Supply and Use

Water Supply/Use	Amount (thousand acre-feet)
Total applied water [a]	222.5
Recharge activities [a]	97.0
Canal & reservoir seepage[a]	50.5
Irrigated acreage [a]	58,551
Pumped groundwater—district [a]	5.8
Pumped groundwater—private [a]	33.8
Crop CUAW [b]	142.6

Source: SSJID 2012.

CUAW = Consumptive Use of Applied Water.

[a] Reported as 1994-2008 average.

[b] Reported as year 2008.

Table 2-17 presents a summary of SSJID water supply and use values from the most recent AWMP. This plan was prepared by the irrigation district as required by Senate Bill X7-7, which was adopted by California in 2009. The AWMP does not provide one summary table for all of the values incorporated in Table 2-17; rather, it presents a wide array of values over multiple years or different time frames. Because the values represent different time frames, there may be inherent inconsistencies between the reported values in Table 2-17. This information is provided to illustrate estimated water supply and use of surface water diversions based on published irrigation district data.

Oakdale Irrigation District

The OID service area covers approximately 70,000 acres in San Joaquin and Stanislaus Counties. The predominant land use in OID is agricultural (approximately 60,000 acres, Table 2-18). More than 95 percent of the water served by OID is surface water diverted from the Stanislaus River at Goodwin Dam into the Joint Supply Canal and the South Main Canal.

Surface water is supplemented by groundwater pumping from 22 groundwater wells located throughout the district on both sides of the Stanislaus River, especially during dry periods when surface water supplies are limited. Approximately 8,000 AF/y is pumped from these wells in dry years. OID also pumps approximately 1,500 AF/y from four shallow wells to control water table levels. Over the last 10 years, these domestic wells have produced approximately 1,000 AF/y (EA EST 1999).

Table 2-18 presents a summary of OID water supply and use values from the most recent AWMP. This plan was prepared by the irrigation district as required by Senate Bill X7-7, which was adopted by California in 2009. The AWMP does not provide one summary table for all of the values incorporated in Table 2-18; rather, it presents a wide array of values over multiple years or different time frames. Because the values represent different time frames, there may be inherent inconsistencies between the reported values in Table 2-18. This information is provided to illustrate estimated water supply and use of surface water diversions based on published irrigation district data.

Table 2-18. Oakdale Irrigation District—Water Supply and Use

Water Supply/Use	Amount (thousand acre-feet)
Surface water supply [a]	232.0
Irrigated acres [b]	55,746
Farm deliveries [a]	186.7
Crop CUAW [a]	128.9
Pumped groundwater—district [a]	7.1
Pumped groundwater—private [a]	19.3
Recharge activities [c]	71.7
Canal seepage [a]	35.6
Deep percolation [a]	24.5

Source: OID 2012.

CUAW = Consumptive Use of Applied Water

[a] Reported as 2005-2011 average.

[b] Reported acreage for year 2010.

[c] Recharge activities include canal seepage, drain seepage, and deep percolation of applied water.

Stockton East Water District

SEWD is a water conservation district that provides surface water for both agricultural and urban uses and groundwater recharge. SEWD covers approximately 116,300 acres, of which approximately 47,600 acres are within the city of Stockton. SEWD supplies wholesale treated surface water, which is retailed to Stockton area customers, several different water districts, and retail suppliers. SEWD delivers a minimum of 20,000 AF/y to these water districts and retail suppliers. Currently, raw water sent to the SEWD Treatment Plant originates from either New Hogan Reservoir on the Calaveras River or New Melones Reservoir on the Stanislaus River.

The estimated average amount of water that SEWD receives from the Calaveras River during a wet year is 67 TAF/y (Northeastern San Joaquin County Groundwater Banking Authority 2004). On the Stanislaus River, SEWD partially owns Goodwin Dam and uses it for diverting water into Goodwin Tunnel, which is at the upstream end of the New Melones Conveyance System. SEWD has a contract with USBR to receive 75,000 AF/y from the New Melones Reservoir through the CVP (SEWD 2011). However, during dry years, water delivery amounts may vary depending upon USBR water allocations. In the past, SEWD contracted with SSJID and OID to receive up to 30,000 AF/y through the New Melones Conveyance System, specifically for municipal use. This agreement ended in 2009, but was extended beyond 2010 and may be renewed pending further studies (SEWD 2014).

Table 2-19 presents a summary of SEWD's water supply and use values from the most recent water management plan. The water management plan does not provide one summary table for all of the values incorporated in Table 2-19; rather it presents a wide array of values over multiple years or different time frames. Because the values represent different time frames, there may be inherent inconsistencies between the reported values in Table 2-19. This information is provided to illustrate estimated water supply and use of surface water diversions based on published data.

Table 2-19. Stockton East Water District—Water Supply and Use

Water Supply/Use	Amount (thousand acre-feet)
Total surface water supply [a]	118.2
Irrigated acres [b]	50,981
CUAW [b]	127.6
Municipal deliveries [b]	52.4
Deep percolation of applied water	13.0
Conveyance system evaporation [b]	4.7
Pumped groundwater—district [b]	0
Pumped groundwater—private [b]	117.4
Recharge activities [c]	53.2
System seepage [b]	29.4

Source: SEWD 2014.

CUAW = Consumptive Use of Applied Water

[a] Total water supply from the Calaveras and Stanislaus Rivers, year 2010, includes Federal Ag. Water, Federal non-Ag. Water, and water transfers.

[b] Reported total for year 2010.

[c] Recharge activities include Farmington GW Recharge Program ponds as well as natural creeks/rivers and canals.

Central San Joaquin Water Conservation District

The CSJWCD service area is approximately 65,000 acres. CSJWCD has contracted with USBR to receive a total of 80,000 AF/y of surface water from the Stanislaus River. Of this total, 49,000 AF/y is a firm supply and 31,000 AF/y is an interim supply subject to other users' requirements. CSJWCD water is diverted through the Goodwin Tunnel at Goodwin Dam. The total contracted amount has never been fully delivered. On occasion, SSJID and OID have also made water available to CSJWCD for irrigation (Northeastern San Joaquin County Groundwater Banking Authority 2004).

Approximately 48,000 acres of CSJWCD land is irrigated. Because the CSJWCD surface water supply has generally been relatively small (in 2009 it was 32 TAF), groundwater has been the primary source of water for meeting irrigation needs. CSJWCD does not pump and sell groundwater, but it charges irrigators for groundwater pumping volumes that are estimated on the basis of an assumed water application rate of 2.8 acre-feet/acre (CSJWCD 2013).

Tri-Dams Project

The Tri-Dam project is a partnership between OID and SSJID. Together they developed, operate, and maintain the Beardsley, Donnells, and Tulloch projects, including the dams, tunnels, penstocks, power houses, communications systems, and general offices. The Tri-Dam facilities are located on the Middle Fork of the Stanislaus River in Tuolumne County.

The project is responsible for providing irrigation water to 117,500 acres of land on farms in San Joaquin and Stanislaus Counties. The Beardsley, Donnells, and Tulloch facilities provide OID and SSJID with storage reservoirs necessary to meet this water obligation. Storage and power are carried out pursuant to the districts' water rights and the districts' license issued by FERC. The Tri-Dam project has 660,000 acre-feet of water rights on the Stanislaus River (Richardson & Company 2010). In 2005, the State Water Board issued a water quality certification for the Tri-Dam Project (Beardsley/Donnels Hydroelectric Project) and in 2006 for the Tulloch Hydroelectric Project. Both certifications contain a reopener provision "to implement any new or revised water quality standards and implementation plans adopted or approved pursuant to [Porter-Cologne] or section 303 of the Clean Water Act" (State Water Board 2005, 2006).

2.5.3 Flow Requirements

Various flow requirements on USBR established through agreements, BOs, and water rights decisions govern the flow released from the dams on the Stanislaus River. Four of these are discussed below: the 1987 Agreement, Decision 1422, USFWS AFRP, and 2009 NMFS BO. In recent drought years, low storage levels in New Melones Reservoir, limited projected inflows and the junior nature of USBR's water rights for New Melones Reservoir, limited supplies are available to USBR to meet its flow and other water quality requirements and maintain water in storage. USBR does not appear to have adequate water in New Melones Reservoir under its water right permits to meet the State Water Board's Water Right Decision D-1641 (D-1641) spring base flow and spring pulse flow requirements in 2016 as well as other requirements without depleting storage in New Melones Reservoir to unreasonably low levels. OID's and SSJID's water rights and other SJR Basin water rights are not conditioned on meeting any of these requirements.

1987 Agreement and Interim Operations Plan

USBR and CDFW executed an agreement titled *Interim Instream Flows and Fishery Studies in the Stanislaus River Below New Melones Reservoir* on June 5, 1987 (1987 Agreement). The interim plan of operations (IPO) increased the fisheries release by changing 98,300 AF from the maximum to the minimum required release and allowed for releases as high as 302,100 AF in wetter years. The exact quantity to be released each year is determined based on a formulation involving storage, projected inflows, projected water demands, and target carryover storage.

State Water Board Water Right Decision 1422

State Water Board Water Right Decision 1422 to USBR specifies flow releases from New Melones Reservoir up to 70,000 AF in any 1 year for water quality control purposes in the LSJR. The flows must maintain a maximum mean monthly total dissolved solids (TDS) concentration below the mouth of the Stanislaus River at 500 parts per million (ppm). They must also maintain at least 5 ppm of dissolved oxygen in the river.

State Water Board Water Right Decision 1641

The State Water Board established flow objectives for the SJR at Vernalis for the period from February through June and the month of October. With the exception of a 31-day pulse flow period from approximately April 15 through May 15, the February through June flows are referred to as the spring base flow objectives. The objectives require a specified minimum monthly average flow rate based on the San Joaquin Valley Water Year Hydrologic Classification (at the 75 percent exceedance level) and include two levels. The higher flow level applies when the 2 parts per thousand (ppt) isohaline (X2[15]) is required to be at or west of Chipps Island pursuant to Table 4 of D-1641. The fall pulse objective in all years except a critical year following a critical year is required to be 1,000 cfs plus up to an additional 28 TAF limited to the amount necessary to provide a monthly average flow of 2,000 cfs. The additional 28 TAF is not required in a critical year following a critical year.

In D-1641, the State Water Board assigned responsibility to USBR for ensuring that all of the SJR flow objectives are met. As part of the San Joaquin River Agreement (SJRA), a voluntary agreement between parties in the SJR Watershed to implement provisions of the 1995 Bay-Delta Plan from 2000 through 2011, USBR and DWR purchased water from other water users in the SJR Watershed to meet some of the SJR flow requirements. Instead of meeting the 1995 Bay-Delta Plan pulse flow objectives (the current D-1641 requirements), the SJRA parties proposed and the State Water Board approved the conduct of the Vernalis Adaptive Management Plan (VAMP). The VAMP provided for generally lower flows and offramps in very dry conditions. The SJRA also provided for the purchase of flows to meet the D-1641 fall flow requirements. After the expiration of the SJRA in 2011, USBR purchased some water to help to meet the SJR flow requirements in 2012 and 2013, but did not fully achieve the requirements. Due to inadequate water supplies in New Melones Reservoir to meet all of USBR's various obligations and the lack of water releases from elsewhere in the SJR Watershed, USBR has repeatedly failed to comply with the SJR flow objectives since the SJRA expired.

U.S. Fish and Wildlife Service AFRP

USFWS requires USBR to provide water for fish flows below CVP reservoirs on the Stanislaus River. This program generally released pulse flows in the April–May period that were coordinated with the VAMP). The AFRP is continuing, although the VAMP ended in 2011. The annual allocation and scheduling of release flows are made annually but are supplemental to the basic IPO flows, described above.

2009 National Marine Fisheries Service BO

Reasonable and Prudent Alternative (RPA) Action 3.1.3 of the June 2009 NMFS BO to USBR for the long-term operation of the CVP and SWP (Operational Criteria and Plan [OCAP])imposes minimum Stanislaus River flows according to a flow schedule as measured at Goodwin Dam. These daily flows are dictated by the lifecycles of species: the fall flow for attraction, spring pulse flow for outmigration cues in wet years, and sustained late-spring flows for outmigration. The flows range from approximately 500 to 1,500 cfs in the fall and approximately 800 to 4,800 cfs in the spring. The daily flow schedule (with several pulse flows) is equivalent to the monthly average RPA flow requirement simulated by the Water Supply Effects (WSE) model. Section 2.6.3 provides additional information regarding the 2009 NMFS BO as it relates to the flows measured on the SJR at Vernalis.

2.5.4 Hydrology

The unimpaired flow of the Stanislaus River is the flow that would occur without existing diversions. The historical flow of the Stanislaus River is influenced by the operation of the existing dams and

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[15] X2 is the location of the 2 parts per thousand salinity contour (isohaline), 1 meter off the bottom of the estuary measured in kilometers upstream from the Golden Gate Bridge. The abundance of several estuarine species has been correlated with X2. In the 2006 Bay-Delta Plan, a salinity value—or electrical conductivity (EC) value—of 2.64 millimhos/centimeter (mmhos/cm) is used to represent the X2 location. Note, in this SED, EC is generally expressed in deciSiemens per meter (dS/m). The conversion is 1 mmhos/cm = 1 dS/cm.

diversions described above. The hydrograph in Figure 2-10 depicts both types of flow over time. It shows that the unimpaired flow at New Melones Dam averaged 1,100 TAF/y and the historical bypasses or releases averaged 611 TAF/y below the Goodwin Dam for the recent 10-year period of water years 2000–2009.[16]

The Goodwin Dam bypasses or releases averaged approximately 55 percent of the unimpaired flow, but the historical flows were usually much less than 50 percent of the unimpaired flow, with flood control releases providing most of the flow below Goodwin Dam. The historical monthly flows at Ripon are generally less than the unimpaired flows in the winter and spring months, and are often slightly higher than the unimpaired flows in the summer and fall months.

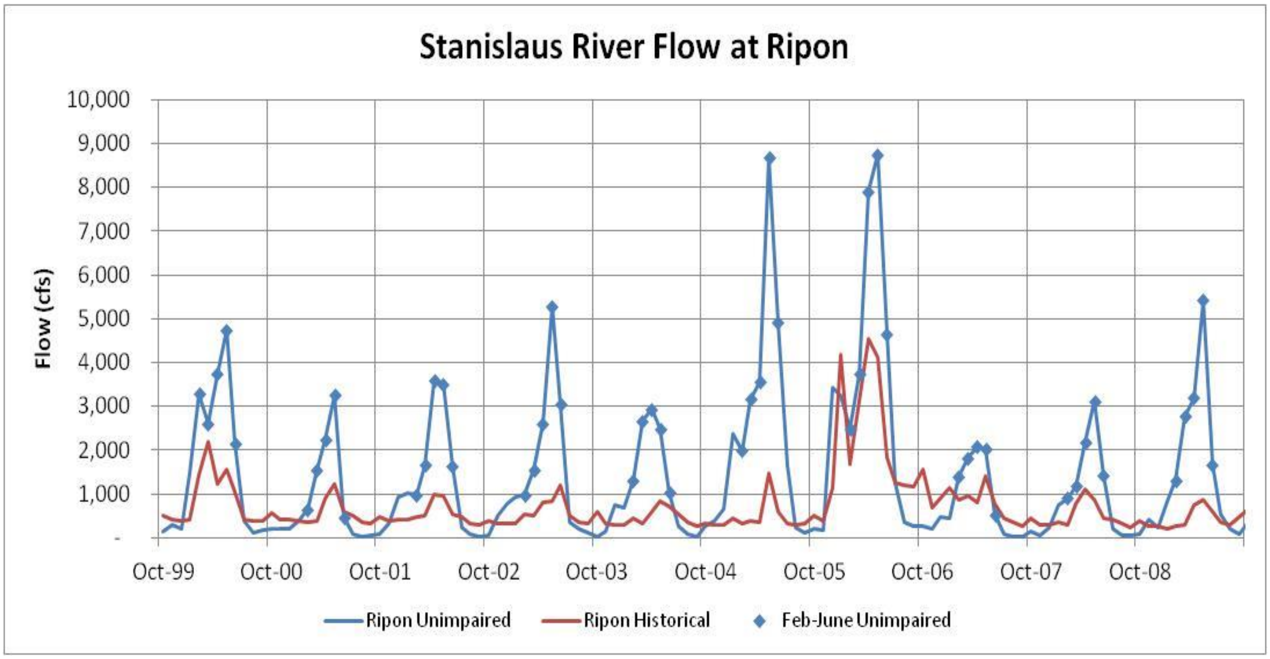

Figure 2-10. Monthly Unimpaired and Historical Stanislaus River Flows February–June for Water Years 2000–2009 (cfs = cubic feet per second)

Table 2-20 summarizes the range of historical and unimpaired flows on the Stanislaus River to demonstrate the baseline hydrology of the river in February–June. The peak historical flows during this period were in 2006 because New Melones Reservoir was nearly full, and relatively high flows ranging from 2,000 to 4,500 cfs were released for flood control purposes.

The Stanislaus River monthly unimpaired flows at New Melones Dam are summarized in Table 2-21, with the cumulative distributions of unimpaired flow (in 10 percent increments) for each month from 1984 through 2009. Each month has a range of runoff depending on the rainfall and accumulated snowpack. The median flows (50 percent cumulative) can be used to generally characterize the seasonal runoff pattern. The peak runoff for the Stanislaus River is observed in May, and highest runoff (median monthly runoff greater than 90 TAF, or 1,500 cfs) is observed March–June. The minimum flows are observed in August, September, and October. The distribution of

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[16] These releases include flood flows in 2000 and 2006.

annual unimpaired flow ranged from 463 TAF (10th percentile) to 2,015 TAF (90th percentile), with a median runoff of 922 TAF. The average unimpaired flow was 1,100 TAF/y, 19 percent more than the median runoff. This represents approximately 18 percent of the estimated unimpaired flow at Vernalis.

Table 2-20. New Melones Reservoir Historical and Unimpaired Flow (cubic feet per second) February–June

Water Year	Historical Range	Unimpaired Range
2000	1,000–2,000	2,000–5,000
2001	250–1,000	500–3,000
2002	500–1,000	1,000–3,500
2003	500–1,000	1,000–5,000
2004	500–750	1,000–3,000
2005	250–1,250	2,000–9,000
2006[a]	2,000–4,500	2,500–9,000
2007	750–1,250	500–2,000
2008	250–1,000	1,000–3,000
2009	250–750	1,000–5,500

[a] New Melones Reservoir was nearly full, and flood control releases were made in each month February–June.

Table 2-21. Monthly and Annual Unimpaired Flow in the Stanislaus River 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	3	5	12	17	29	67	105	95	30	5	2	1	463
20	5	8	13	23	35	79	130	153	41	12	4	1	510
30	6	10	14	27	50	90	135	167	57	14	5	2	595
40	9	13	15	42	55	102	157	192	94	19	6	3	752
50	10	16	27	55	75	127	178	224	103	22	7	4	922
60	11	18	31	86	90	160	206	297	128	24	10	6	1,162
70	12	24	42	100	104	176	218	329	178	40	13	6	1,463
80	13	31	47	146	138	215	245	370	215	57	16	10	1,692
90	17	44	105	191	224	233	254	446	285	89	21	18	2,015

Compared to the other two eastside tributaries, the Tuolumne and Merced Rivers, the Stanislaus River historical flows are relatively high because of the minimum flow requirements for fish; additional releases for salinity control; AFRP flow releases for anadromous fish in April, May, and June; and the VAMP flow releases in April and May. The New Melones Reservoir is the largest reservoir on the SJR tributaries and has considerable carryover storage from one year to the next. Therefore, flood control releases are not necessary each year; consequently, it is difficult to anticipate when reservoir releases for flood control storage will be required. The monthly historical flows are summarized in Table 2-22 with the cumulative distributions (in 10 percent increments) from 1984 through 2009. The majority of the historical monthly flows were between 10 TAF and 40 TAF (150 cfs and 600 cfs). The annual river flow volume ranged from 310 TAF (10th percentile) to 1,249 TAF (90th percentile). The median historical annual river flow was 429 TAF. The average historical flow was 611 TAF/y, which is 42 percent more than the median. The average historical flow of 611 TAF was approximately 55 percent of the average unimpaired flow, but most of this flow was observed in the wet years with flood control releases.

Table 2-22. Monthly and Annual Historical (Observed) Flow in the Stanislaus River 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	20	17	14	12	13	19	30	33	28	21	19	16	310
20	21	19	17	15	17	24	36	47	33	25	20	18	333
30	24	19	19	20	18	31	45	51	35	27	22	19	351
40	27	19	20	24	20	43	49	54	36	29	23	19	386
50	30	22	22	25	26	53	53	63	41	31	25	23	429
60	32	24	25	29	41	67	57	77	49	34	27	25	532
70	35	25	28	40	65	77	66	87	58	39	33	28	624
80	43	27	55	69	91	135	75	92	70	45	39	33	967
90	74	43	65	182	150	181	109	98	77	65	74	57	1,249

2.6 Lower San Joaquin River

2.6.1 Basin Overview

The drainage area of the SJR above Vernalis encompasses approximately 12,250 square miles. All of the SJR flow from upstream of the Merced River (including the Friant Dam flood control releases) as well as the tributary flows from the three eastside tributaries are combined and measured at the Vernalis Bridge. On the west side of the LSJR, tributary streams include Hospital, Del Puerto, Orestimba, San Luis, and Los Banos Creeks. These intermittent streams are commonly referred to as the westside tributaries to the SJR. However, at times of high rainfall, these streams contribute significant runoff to the LSJR. Vernalis, an unincorporated community in San Joaquin County downstream of the Stanislaus River and upstream of tidal effects from the Delta, is where the LSJR enters the southern Delta.

The water for irrigated agriculture in the San Joaquin Valley is supplied by the LSJR and its tributaries and the Delta-Mendota Canal (DMC), which conveys water from the southern Delta to the Mendota Pool. The CVP Jones Pumping Plant (with seasonal storage in San Luis Reservoir) exports water from the southern Delta through the DMC, supplying the SJR exchange contractors and several water districts along the DMC that have contracts for CVP water supplies.

2.6.2 Water Diversion and Use

The LSJR within the plan area includes the confluences of the Stanislaus, Tuolumne, and Merced Rivers. The stretch of river from the Merced River confluence north to Vernalis has approximately 40 diversions. Of these diversions, approximately 15 are covered under appropriative water rights, and approximately 25 diversions are claimed under Statements of Water Use and Diversion.
The major use of diverted water is for agricultural and domestic uses (State Water Board 2015).

2.6.3 Flow Requirements

Various flow requirements established through basin plans and agreements have governed the flow at Vernalis, including objectives in the 1995 and 2006 Bay-Delta Plans, SJRA, VAMP, D-1641, and 2009 NMFS BO.

The State Water Board first established LSJR flow objectives in the 1995 Bay-Delta Plan. The flow objectives were primarily intended to protect fall-run Chinook salmon and provide incidental benefits to Central Valley steelhead. The objectives were unaltered in the 2006 Bay-Delta Plan, but as authorized in D-1641, the 2006 Bay-Delta Plan allowed for the VAMP (discussed below) to be conducted instead of the plan's April 15–May 15 pulse flow requirements.

The SJRA signatory parties, including the California Resources Agency, U.S. Department of the Interior, San Joaquin River Group, CVP/SWP Export Interests, and two environmental groups, agreed that the San Joaquin River Group Authority (SJRGA) members would meet the experimental flows specified in the VAMP program in lieu of meeting the spring pulse flow objectives adopted in the 2006 Bay-Delta Plan. The VAMP, which ended in 2011, was a 12-year program designed to protect juvenile Chinook salmon migration from the LSJR through the Delta. It was also a scientific experiment with monitoring to determine how juvenile fall-run Chinook salmon survival rates change in response to alterations in LSJR flows and CVP and SWP exports as a result of the installation of the Head of Old River Barrier (HORB). The VAMP was designed to assess a combination of flows, varying between 3,200 cfs and 7,000 cfs, and exports varying between 1,500 cfs and 3,000 cfs.

The SJRA included flows for the October pulse flow objective. Supplemental water up to 28,000 AF was also released in October during all water year types. The amount of additional water was limited to that amount necessary to provide a monthly average flow of 2,000 cfs at Vernalis.

As discussed above in the Stanislaus River section, under D-1641, USBR is assigned responsibility for ensuring that all of the SJR flow objectives are met. Due to inadequate water supplies in New Melones Reservoir to meet all of USBR's various obligations and the lack of water releases from elsewhere in the SJR Watershed, USBR has repeatedly failed to comply with the SJR flow objectives since the SJRA expired.

The 2009 NMFS BO for the long-term OCAP included several RPAs related to New Melones Reservoir operations and the Stanislaus River that affect the flows at Vernalis. RPA action IV 2.1 requires a minimum LSJR inflow-to-export ratio and minimum flows at Vernalis based on SJR water year type during the 2-month pulse flow period of April and May. (USBR and DWR are required to seek a supplemental agreement with SJRGA to achieve these minimum long-term flows at Vernalis.) The LSJR inflow-to-export ratio is the inverse of the already established Delta Export/Inflow (E/I) ratio, which is calculated using the total Delta inflow. The LSJR inflow-to-export ratios are more restrictive and allow the exports to be 100 percent of the LSJR inflow in critical years, 50 percent of the LSJR inflow in dry years, 33 percent of the LSJR inflow in below normal years, and 25 percent of the LSJR inflow in above normal or wet years. As indicated in Table 2-23, these criteria effectively limit exports to 1,500 cfs during April and May unless the LSJR is higher than the minimum flow required in these months.

Table 2-23. Minimum April and May Vernalis Flows (cubic feet per second)

San Joaquin River (60-20-20) Index Year Types	Minimum Flow at Vernalis	Corresponding Exports
Critical	1,500	1,500
Dry	3,000	1,500
Below Normal	4,500	1,500
Above Normal	6,000	1,500
Wet	6,000	1,500

2.6.4 Hydrology

Construction and operation of the numerous water supply, hydroelectric, and flood control reservoirs during the twentieth century upstream of Vernalis have significantly modified the flows at Vernalis in comparison to the historical (observed) flows. Peak flows currently occur earlier in the year—during February, March, April, and May, rather than in May and June as occurred under the unimpaired flow regime. Figure 2-11 shows the monthly unimpaired and historical flows at Vernalis for the recent 10-year period of water years 2000 through 2009. The unimpaired flows at Vernalis average 6,056 TAF/y and the historical flows (including flood flows in 2000, 2005, and 2006) average 2,915 TAF/y.

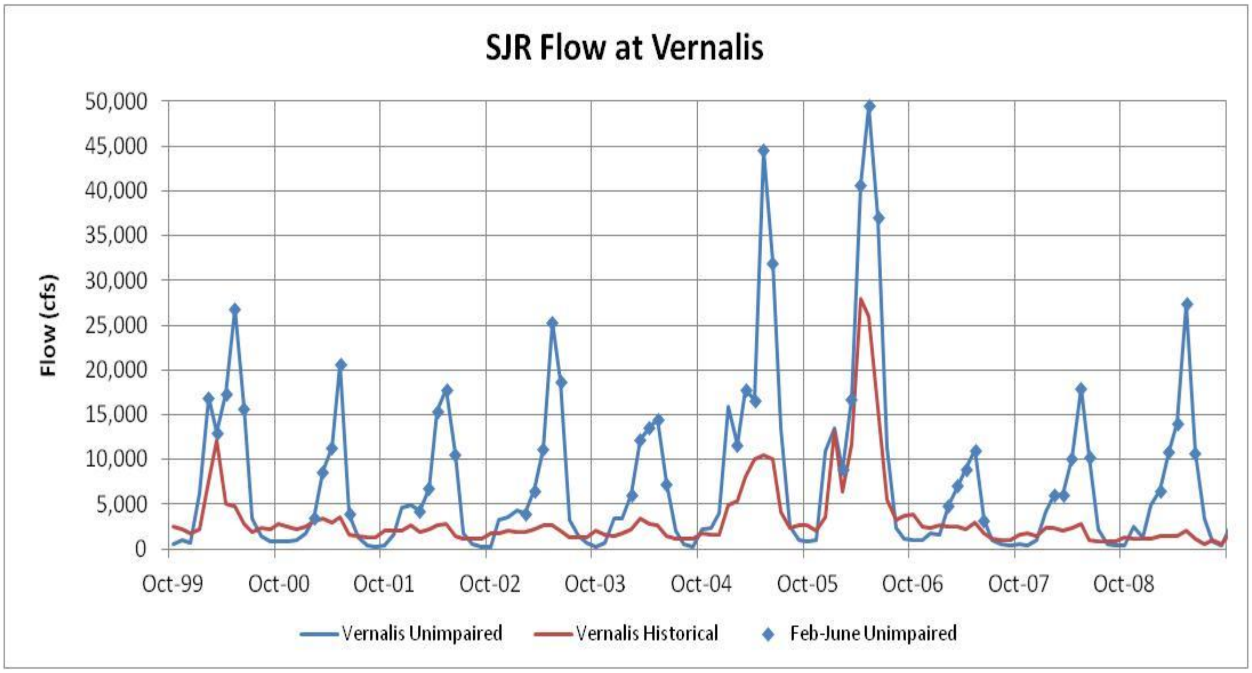

Figure 2-11. Monthly Unimpaired and Historical LSJR Flows at Vernalis February–June for Water Years 2000–2009 (cfs = cubic feet per second)

The historical (1930–2009) Vernalis flows average approximately 48 percent of the unimpaired flow, but the releases were usually much less than 40 percent of the unimpaired flow, with flood control releases providing the majority of the flow. The historical monthly flows at Vernalis were generally lower than the unimpaired flows in the winter and spring months, and were often slightly higher than the unimpaired flows in the fall months.

Observed flow at Vernalis after 1984 reflects conditions that existed following completion and filling of New Melones Reservoir in 1983. Tables 2-24 and 2-25 show the monthly unimpaired and historical flows, respectively, for the SJR at Vernalis from 1984 through 2009. The hydrologic variability in the SJR Basin after 1983 has been substantially altered, with greatly reduced monthly flows and annual runoff volumes. The median annual unimpaired flow in the SJR at Vernalis was 4,578 TAF, while the median annual historical runoff was 1,718 TAF, or approximately 38 percent of unimpaired flow.

Table 2-24. Monthly and Annual Unimpaired Flow in the San Joaquin River at Vernalis 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	15	35	49	77	148	326	557	631	238	84	29	15	2,555
20	22	41	62	97	169	380	645	820	337	105	34	18	2,681
30	33	50	70	121	226	412	672	981	447	111	38	20	3,468
40	39	55	102	208	275	490	714	1,095	630	145	44	28	3,753
50	49	70	125	284	339	587	892	1,424	773	208	55	37	4,578
60	57	76	160	378	482	719	926	1,600	874	232	94	44	6,102
70	62	145	211	387	553	802	984	1,763	1,122	324	108	52	7,868
80	75	156	225	773	726	998	1,144	1,941	1,643	478	139	61	10,082
90	100	209	491	948	1,071	1,099	1,421	2,307	2,141	833	169	82	11,242

Table 2-25. Monthly and Annual Historical (Observed) Flow in the San Joaquin River at Vernalis 1984–2009 (thousand acre-feet)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
10	65	67	65	72	78	109	87	94	63	45	45	52	891
20	84	77	80	91	104	130	114	121	66	70	62	56	1,168
30	91	95	89	114	114	135	138	133	88	73	69	68	1,300
40	108	102	97	131	127	157	155	163	102	81	79	81	1,396
50	125	110	113	146	155	187	167	174	111	89	98	91	1,718
60	161	121	130	159	180	211	204	217	137	108	121	121	2,108
70	170	136	138	252	361	504	290	295	161	123	129	134	3,678
80	230	151	216	291	486	744	446	518	222	157	160	165	5,227
90	293	168	280	590	655	913	1,176	872	714	298	212	223	6,539

Increased storage and water supply diversions have resulted in flow conditions that are more static with less seasonally variable flows throughout the year. There are now reduced flows in the winter and spring months, with increased flow in the fall, both of which combine to create managed flows that diverge significantly from what would occur under unimpaired conditions.

2.7 Southern Delta

The LSJR enters the southern Delta at Vernalis. When the Head of Old River Barrier is not in place, about half of the LSJR volume flows west into Old River (which diverges from the LSJR downstream of Mossdale and connects with Middle River and the Grant Line Canal) and is typically diverted by the CVP and SWP export pumps, and about half continues north toward Stockton. Most of the lands in the southern Delta are within the South Delta Water Agency (SDWA) in San Joaquin County. Figure 2-12 shows the outline of the SDWA relative to the San Joaquin County line and the legal boundary of the Delta. Of the nearly 150,000 acres within the southern Delta, irrigated lands comprise approximately 100,000 acres. The non-irrigated area includes urban lands, watercourses, levees, farm homesteads, islands within channels, and levees. Just west of the plan area in the southern Delta are the CVP and SWP pumping plant intakes. Just outside the plan area to the north and west are two CCWD intakes. Figure 2-12 shows the location of these intakes and of wastewater treatment plant (WWTP) facilities that discharge treated effluent into the southern Delta.

Southern Delta salinity concentrations are affected by numerous factors, including the amount and salinity concentration of SJR flow entering the southern Delta at Vernalis, daily tidal action, CVP and SWP pumping operations, agricultural return flows, municipal wastewater discharges, and other influences. These are discussed in more detail below.

2.7.1 Lower San Joaquin River and Tidal Conditions

Water enters the southern Delta channels along three major pathways: from the LSJR west through Old River and Grant Line Canal toward the CVP Jones and SWP Banks pumping facilities; from the central Delta through Middle River and Victoria Canal; and from the central Delta through Old River and West Canal to the Clifton Court Forebay (CCF) and the DMC. Approximately 50 percent of the LSJR flow splits into the Old River channel, and the other 50 percent continues down the LSJR channel toward Stockton. During storm flows of greater than approximately 15,000 cfs at Vernalis, the Paradise Cut weir (elevation 12.5 ft) diverts some of the flow at LSJR mile 60 into Paradise Cut toward Grant Line Canal, reducing the LSJR flow at Mossdale and the Head of Old River.

There are three major southern Delta channels: Old River channel, Middle River channel, and Grant Line Canal. The Old River channel flows west about 4 miles to the upstream end of Middle River and continues past Doughty Cut (which connects with the upstream end of Grant Line Canal) toward Tracy. The Old River channel in the vicinity of Tracy is the southernmost Delta channel. The Old River channel length between the Head of Old River and the CVP Tracy Facility (DMC and fish facility) is about 24 miles, with a surface area of about 550 acres and a volume of 3,500 AF at an elevation of 0 ft mean sea level (MSL). Most of the Old River flow moves through Doughty Cut to Grant Line Canal.

Middle River is a relatively narrow and shallow channel that extends 12 miles from its head to Victoria Canal. The surface area of Middle River is approximately 175 acres, with a volume of 750 AF at an elevation of 0 ft MSL. Export conditions (described further below) pull water from the Sacramento River and create cross-Delta water conditions. This cross-Delta water flows south (upstream) in the portions of Old and Middle Rivers that are north of the exports. Approximately 60 percent of this Old and Middle River (OMR) flow is in the Old River channel and approximately 40 percent is in the Middle River and Victoria Canal, because Victoria Canal is shallow and Old River is a larger conveyance channel.

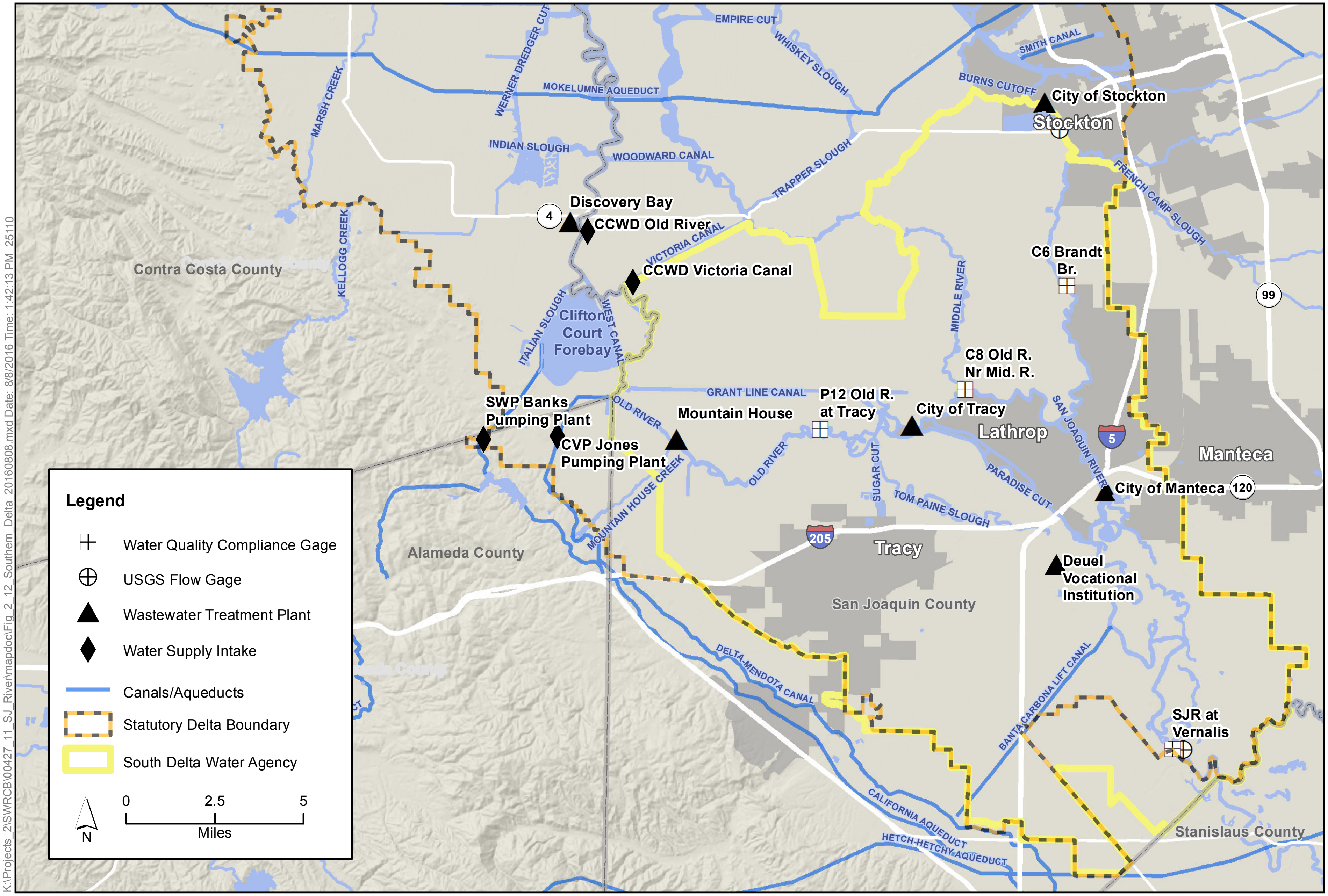

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Figure 2-12
Vicinity Map of Southern Delta

The third major channel is the Grant Line Canal, which is about 7.5 miles long and extends from near Doughty Cut to the Old River channel just north of the Tracy fish facility. The surface area of the Grant Line Canal is approximately 400 acres, with a volume of approximately 3,250 AF at an elevation of 0 ft MSL. The Fabian and Bell Canal, which runs parallel to and is interconnected with Grant Line Canal for much of its length, is included in these measurements.

The total surface area of these three major southern Delta channels is approximately 1,125 acres with a volume of 7,500 AF at a water surface elevation of 0 ft MSL. As the tidal elevation fluctuates, the surface area and volume change. The average southern Delta tidal fluctuation is approximately 3 ft (i.e., from -1 to 2 ft), and the surface area increases from 1,000 acres at low tide to 1,250 acres at high tide (Delta Simulation Model 2 [DSM2]). The southern Delta channel volume increases from approximately 6,000 AF at low tide to approximately 9,500 AF at high tide, a change of approximately 3,500 AF. This tidal volume, also known as the tidal prism, moves into and out of the southern Delta channels twice each day, constituting an average tidal flow of approximately 3,500 cfs flowing into these channels during the flood tides (for about 12 hours each day) and approximately 3,500 cfs flowing out during the ebb tides.

The longitudinal movement of water between low tide and high tide depends on the cross-section of the channels but averages several miles in the southern Delta channels. This tidal movement provides considerable mixing and diluting of the agricultural drainage and wastewater discharges in the southern Delta channels. The CCF gates are usually operated to remain closed during flood tide periods to preserve as much upstream flow into the southern Delta channels as possible and to maintain the high tide elevations. Sacramento River water moving toward the export pumps from the central Delta through Old and Middle Rivers is tidally mixed with LSJR water in the vicinity of CCF and the DMC intake, with some Sacramento River water moving upstream in Old River and Grant Line Canal during flood tide, and some LSJR water moving downstream past CCF in West Canal, Old River, and Victoria Canal during ebb tide.

The HORB is a temporary rock barrier that has often been installed by DWR in the fall (late September through November). The barrier reduces the normal diversion of SJR flow into Old River. When the rock barrier is installed, the majority of the LSJR flows north to the Stockton Deep Water Ship Channel. However, some of the LSJR flow is drawn through Turner Cut and Middle River and Victoria Canal toward the CVP and SWP pumping facilities. The barrier is meant to increase flow in the Stockton DWSC and improve the migration of adult SJR Chinook salmon. The HORB was also installed in the spring during the VAMP pulse flow period to reduce the number of juvenile SJR Chinook salmon diverted into Old River and subsequently entrained (or salvaged) at the CVP and SWP fish collection facilities. The increased flow past Stockton was intended to improve the survival of SJR fish migrating through the Delta to Chipps Island.

2.7.2 Water Diversions

The two major water export facilities in the Delta are the CVP and SWP, which are both located west of Tracy just outside the western boarder of the SDWA boundary. The CCWD also diverts water from the southern Delta at Old River and Victoria Canal. These facilities and their influence on southern Delta circulation and salinity are described below.

Export Facilities

CVP Jones Pumping Plant

The CVP Jones Pumping Plant, formerly known as the Tracy Pumping Plant, is located about 5 miles northwest of Tracy. The Jones Pumping Plant consists of six pumps with a permitted diversion capacity of 4,600 cfs. It is located at the end of an earth-lined intake channel approximately 2.5 miles long. The Tracy Fish Collection Facility is located at the entrance to the intake channel on Old River. Water is pumped approximately 200 ft into the DMC, which, as mentioned earlier, delivers water to LSJR water rights holders at Mendota Pool (exchange contractors) and CVP contractors along the DMC and conveys water to San Luis Reservoir for seasonal storage.

The southern Delta CVP contractors are composed of three separate water demand types: CVP water service contractors, exchange contractors, and wildlife refuge contractors. Exchange contractors "exchanged" their senior rights to water in the LSJR for a CVP water supply from the Delta. USBR guaranteed the exchange contractors a firm water supply of 840 TAF/y, with a maximum reduction to 650 TAF/y. The exchange allowed USBR to build Friant Dam and to divert the LSJR water supply to the Friant-Kern and Madera Canals. Additional CVP contactors and wildlife refuge water supply contracts total almost 3,500 TAF/y of water supply demand for the Jones Pumping Plant.

SWP Banks Pumping Plant

The Harvey O. Banks Pumping Plant has a physical pumping capacity of 10,300 cfs. However, flow diverted from the Delta into CCF is limited by a USACE permit under Section 10 of the Rivers and Harbor Act to a maximum of 6,680 cfs during much of the year. SWP exports are diverted into CCF and then pumped at the Banks Pumping Plant into the California Aqueduct (State Water Board 1999). This exported water is pumped into the South Bay aqueduct, pumped into San Luis Reservoir for seasonal storage, pumped farther south in the California Aqueduct to Kern County Water Agency, pumped over the Coast Range in the Coastal Aqueduct, or pumped over Tehachapi Pass to southern California contractors. The total water supply demand for the Banks Pumping plant is approximately 4,000 TAF/y.

CVP and SWP Exports

CVP and SWP export pumping are subject to 2006 Bay-Delta Plan objectives, which are implemented through D-1641. Both the CVP and the SWP have maximum permitted pumping rates. Delta outflow requirements may limit export pumping if the combined Delta inflow is not enough to satisfy both the in-Delta agricultural diversions described earlier in this chapter and the CVP and SWP pumping. The coordinated operations agreement (COA) governs the CVP and SWP share in reservoir releases and Delta pumping.

Export rates are also limited by the 2008 USFWS and the 2009 NMFS BOs for the long-term OCAP of the CVP and SWP. These two BOs added limits on the reverse (negative) OMR flows December–June. The BOs allow a range of reverse OMR limits to be imposed for delta smelt and salmonid protection, but the largest monthly average reverse OMR flows for December–June are negative 5,000 cfs. This effectively limits the CVP and SWP exports to approximately 5,000 cfs plus one-half of the LSJR flow at Vernalis.

The 1995 Bay-Delta Plan introduced the E/I ratio, which limits the combined export to a specified monthly fraction of the combined Delta inflow. The E/I ratio is 35 percent February–June and

65 percent June–January. The February E/I can be increased to 45 percent under low-flow conditions. This E/I objective allows a maximum pumping that is often similar to the allowable exports under the Delta outflow objectives, but sometimes the E/I ratio is more limiting than the required outflow. At other times, the exports must be further reduced to increase the Delta outflow to satisfy the salinity requirements at Emmaton and Jersey Point or at CCWD's Rock Slough diversion.

The monthly cumulative distribution of CVP and SWP pumping for water years 1984 through 2009, which corresponds to the LSJR historical and unimpaired flows, suggests that the CVP pumping is uniform throughout most of the year. The largest reductions in pumping occur during April–June for fish protection. The median CVP pumping was greater than 3,500 cfs in all months except April, May, and June. The SWP pumping shows a greater range from year to year in most months. The median SWP pumping is 3,000–4,000 cfs from October to March, and approximately 2,000 cfs in April, 1,000 cfs in May, and 2,000 cfs in June. SWP pumping has been greatest in July–September with a median pumping of approximately 5,000 cfs because of the peak irrigation demand and because reduced pumping for fish protection is not usually required in these months.

CCWD Intakes

CCWD has four surface water intakes: Mallard Slough Intake, Rock Slough Pumping Plant #1, Old River Intake near State Route 4, and Victoria Canal Intake. The Old River and Victoria Canal Intakes are immediately north/northwest of the SDWA boundary (Figure 2-12). The Mallard Slough and Rock Slough Intakes are located farther west and closer to the ocean. The Old River Intake is the largest intake, accounting for the majority of surface water diverted by CCWD (CCWD and USBR 2006).

Generally, CCWD intakes are located where the effects of seawater intrusion are very pronounced. Therefore, salinity at CCWD intakes can vary substantially over the course of a year. CCWD's intakes typically experience relatively fresh conditions in the late winter and early spring, and salinity increases in summer and fall as conditions become drier and regulatory standards governing Delta operations shift. For example, in dry years, salinity begins to increase in July, while in wet years, an increase in salinity may not occur until September. Additionally, periods with high agricultural drainage contributions in the summer may increase salinity loads that CCWD diverts, as agricultural return flows tend to carry higher salt concentrations (CCWD and USBR 2006).

Use of the Mallard Slough Intake is generally restricted due to salinity concentrations because it experiences more tidal fluctuations as a result of its location. Water quality conditions have restricted diversions from Mallard Slough (an average of 3,100 AF/y) with no diversions available in dry years. When Mallard Slough supplies are used, CVP diversions at Rock Slough are reduced by an equivalent amount. The Victoria Canal Intake allows CCWD the flexibility to divert water with lower salinity and allows seasonal operations shifts between diversions. The seasonal variation in salinity between Old River/Rock Slough and Victoria Canal allows CCWD to divert predominantly in winter and spring from Old River and in the summer and fall from Victoria Canal (CCWD and USBR 2006).

2.7.3 Return Flows

Return flows in the southern Delta are those flows generated by different uses and then discharged (or returned) to the receiving waters of the southern Delta. There are two primary sources of return flows in the southern Delta: discharges from the existing WWTPs and agricultural discharges from irrigators in the southern Delta. These two sources are discussed below.

Wastewater Treatment Plants

Existing WWTPs are considered point sources and discharge salt into the southern Delta, thereby influencing southern Delta salinity. There are six WWTPs that discharge into the southern Delta, all of which are required to comply with effluent limitations established by National Pollution Discharge Elimination System (NPDES) permits. Effluent limitations that regulate the quality of the effluent discharged from the WWTPs are set for a wide variety of constituents, including salt. Chapter 13, *Service Providers*, provides additional information and specific characteristics for each WWTP. Table 2-26 lists these six WWTPs with discharges into the southern Delta, their receiving water bodies, and their total permitted discharge rate.

Table 2-26. Wastewater Treatment Plants with Discharges into the Southern Delta

Facility Name	Receiving Water	Current Permitted Discharge (million gallons per day)
City of Tracy WWTP	Old River	16
Deuel Vocational Institution	Paradise Cut and Old River	0.62
City of Manteca Wastewater Quality Control Facility	San Joaquin River	17.5
Stockton Regional Wastewater Control Facility	San Joaquin River	55
Mountain House Community Service District WWTP	Old River	5.4
Discovery Bay WWTP	San Joaquin River	2.1

WWTP = wastewater treatment plant

The City of Tracy WWTP discharge has limited effects on the salinity in the southern Delta compared to other sources of salinity, including drainage and runoff from agricultural activities and groundwater accretions. Salinity loads from the City of Tracy, Deuel Vocational Facility, and Mountain House CSD WWTPs are a small percentage of the salt load entering from upstream (Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*).

Agricultural Discharges

Various crops in the southern Delta are irrigated primarily with surface water through numerous local agricultural diversions of existing surface waters. Many small agricultural diversions (siphons and pumps) move water throughout the Delta during the spring and summer irrigation season. All of the Delta islands and tracts use these drainage pumping stations to pump off stormwater runoff as well as seepage during the winter and discharge it into the Delta channels. Once the land has been irrigated, water not evapotranspired by the crops returns to the surface waters through either groundwater recharge (as a result of the high water table) or through runoff over the lands. As irrigation water is continually applied, salt infiltrates and builds up in the soil. Salt-leaching from the fields occurs naturally during the rainy season or may be managed by applying water in the fall or winter to maintain the soil salinity within acceptable bounds. Chapter 11, *Agricultural Resources*, and Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*, provide specific information about the current crop mix and salinity tolerances of each crop.

2.7.4 Water Quality and Water Quality Objectives

The LSJR delivers water of relatively poor quality to the Delta, with agricultural drainage to the river being a major source of salts and pollutants (i.e., boron, selenium, pesticides). During periods of high flow, water quality generally improves. Because the southern Delta receives a substantial portion of its water from the LSJR, the influence of this relatively poor LSJR water quality is greatest in the southern Delta channels. Vernalis, upstream of the southern Delta Channels, is a focal point on the LSJR as the three eastside tributaries contribute to the combined flow of the SJR at Vernalis. Flow at Vernalis represents the positive inflow that the LSJR contributes to the southern Delta. The LSJR flow at Vernalis has a large effect on the salinity at Vernalis and the southern Delta. Higher flows generated by reservoir releases or decreased diversions generally reduce the salinity by diluting the LSJR, which tends to be higher in salt from agricultural return flows. Higher CVP and SWP pumping also results in reduced southern Delta salinity as higher pumping brings more Sacramento River water across the Delta to the export pumps. The State Water Board has conditioned the water right permits held by DWR and USBR on meeting salinity standards at compliance locations. DWR and USBR meet the salinity standards by changing water project operations, particularly releases from New Melones on the Stanislaus River. Historically, southern Delta water quality has generally ranged from 0.2 deciSiemens per meter (dS/m) to 1.2 dS/m. Salinity generally remains below 1.0 dS/m when salinity at Vernalis is less than approximately 0.9 dS/m (see Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*).

The four D-1641 water quality compliance stations in the southern Delta are at the following locations (shown in Figure 2-12): SJR at Airport Way Bridge near Vernalis (C-10), Old River at Tracy Road Bridge (C-6), Old River near Middle River (C-8), and SJR at Brandt Bridge (P-12). Currently, the salinity objective set for the southern Delta and measured at these four salinity (electrical conductivity [EC][17]) compliance stations is a maximum 30-day running average of mean daily EC of 0.7 dS/m from April 1 through August 30 and 1.0 dS/m from September 1 through March 31 for all types of water year. Since D-1641 was implemented in 2000, the objective at Vernalis have generally been met. However, compliance with the southern Delta salinity objective at the three interior stations (C-6, C-8, and P-12) has not always been achieved (see Chapter 5 and Appendix F.1, *Hydrologic and Water Quality Modeling*, for a description of exceedances). There is a strong relationship of increasing salinity from Vernalis to the interior stations under most conditions.

2.8 San Joaquin Valley Groundwater Basin

The plan area lies almost entirely within the boundaries of four subbasins on the east side of the San Joaquin Valley Groundwater Basin: Eastern San Joaquin, Modesto, Turlock, and Merced (Figure 2-3). Small portions of the plan area also lie within small parts of three additional subbasins: Tracy,

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[17] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

Chowchilla, and Delta-Mendota (Figure 2-3). A summary of the subbasins and their associated irrigation districts is described in Sections 2.8.1 through 2.8.4 geographically from north to south. Further information regarding groundwater, and the subbasins, is in Chapter 9, *Groundwater Resources*.

Groundwater accounts for approximately 30 percent of the annual agricultural and municipal water supply within the SJR Hydrologic Region, and many cities in this area rely either wholly or partially on groundwater to meet municipal and community non-agricultural needs (DWR 2003a). More than half of all land within the subbasins is irrigated agriculture, and thus the largest use of groundwater is for agricultural purposes.

Although agricultural application of surface water provides significant contribution to groundwater recharge, groundwater levels in the San Joaquin Valley Groundwater Basin have generally declined as a result of extensive pumping. A USGS study of Central Valley groundwater shows that groundwater storage in the San Joaquin Valley Groundwater Basin has varied by plus or minus 5 million AF between 1962 and 2002, but the total storage of the San Joaquin Valley Groundwater Basin was about the same in 2002 as in 1962 (USGS 2009). DWR conducted a recent groundwater evaluation of all groundwater subbasins in California with potential water shortages and prioritized all of the subbasins to assess and rank them throughout the state (DWR 2014). The subbasin prioritization process is based on an evaluation of eight required data components specified by the California Water Code. All the subbasins within the plan area were identified as high priority by DWR and are considered to be at high risk of overdraft (DWR 2014). The Merced, Modesto, and Turlock subbasins experienced varying degrees of overdraft and recharge conditions between 1970 and 2000; however, each subbasin experienced a net overdraft condition during this period as indicated by average declines in groundwater elevation of approximately 30, 15, and 7.5 ft, respectively, with the eastern portion of the subbasins experiencing more severe overdraft (DWR 2003c, 2003d, 2003e). The Eastern San Joaquin subbasin has been in a consistent overdraft condition (approximately 1.7 ft/year) for the same time period. It is estimated that the overdraft has reduced storage in the basin by 2 million acre-feet over a 40-year period (DWR 2003e). Additional pumping in any of the subbasins would increase the drawdown, with a noticeable effect on groundwater levels over a number of years. Additional pumping and overdraft can also cause land subsidence. In the southern portion of the study area, increased dependence on groundwater during the recent drought resulted in groundwater levels approaching or surpassing historic lows, which caused aquifer-system compaction and land subsidence that most likely is permanent (Sneed and Brandt 2015). Further information regarding groundwater, and the subbasins, is in Chapter 9.

2.8.1 Eastern San Joaquin Groundwater Subbasin

The Eastern San Joaquin Subbasin is drained by the SJR and several of its major tributaries, mainly the Stanislaus, Calaveras, and Mokelumne Rivers. The subbasin is located under the urban centers of Manteca, Lathrop, Ripon, and Stockton, which use groundwater for a large portion of their drinking water supply.

The subbasin spans approximately 707,000 acres and includes several water and irrigation districts. SEWD, CSJWCD, SSJID, and a portion of OID fall within the subbasin boundaries. Water use within these districts is primarily for irrigation of approximately 200,000 acres. There are approximately 200,000 acres of irrigated land outside these irrigation districts but within the subbasin boundary (Table 9-5). These districts rely on surface water and groundwater to fulfill customer demand throughout the irrigation season. The agricultural areas outside these irrigation district lands are more dependent on groundwater, although some of these lands receive surface water from the Mokelumne River and SJR.

Historically, pumping from urban, rural, and agricultural wells has been above the safe yield of the subbasin (SSJID 2012). Groundwater levels have continuously declined over the past 40 years at an average rate of 1.7 ft/year and have dropped as much as 100 ft in some areas (USACE 2001 in DWR 2003b). Significant groundwater depressions are present under the city of Stockton, east of Stockton, and east of Lodi (SJCFC 1999 in DWR 2003b). However this cone of depression is not as severe as it once was; between 2005 and 2010, groundwater elevations within some portions of this area showed some signs of improvement.

Groundwater recharge is primarily from deep percolation of applied irrigation water, conveyance losses, and precipitation. Additional recharge also occurs as a result of lateral inflows from other subbasins and seepage from rivers, creeks, and reservoirs (Northeastern San Joaquin County Groundwater Banking Authority 2004). In recent years, multiple methods have been used to increase groundwater recharge in this subbasin. These methods include installation of check dams on waterways, increased use of surface water, creation of surface ponds, and flooding of fields (CSJWCD 2013; SEWD 2014). These recharge efforts have likely improved groundwater conditions in the subbasin. Between 2005 and 2010, some of the areas with the lowest groundwater levels in this subbasin experienced increases in groundwater levels at the same time that levels dropped in other subbasins (DWR 2015).

2.8.2 Modesto Groundwater Subbasin

The Modesto Subbasin is bordered by the Stanislaus River to the north and the Tuolumne River to the south. The subbasin is located under the urban centers of Modesto, Oakdale, and Riverbank, and under small areas of the southern boundary of Ripon. These cities use groundwater for a large portion of their drinking water supply.

The subbasin encompasses approximately 247,000 acres and includes MID and a portion of OID. These irrigation districts rely on surface water and groundwater to fulfill customer demand throughout the irrigation season. Approximately 116,000 acres are irrigated (Table 9-5), with approximately 77 percent of these acres being supplied with surface water from OID or MID.

Groundwater levels in this subbasin decreased at an estimated 0.5 foot/year during 1970–2000 (DWR 2003c), with groundwater declines coinciding with dry periods and stabilization and recovery coinciding with wet periods. Water level declines have been more severe in the eastern portion of the subbasin (DWR 2015).

Groundwater recharge is primarily from deep percolation of applied irrigation water and canal seepage from MID and OID facilities. Seepage from Modesto Reservoir is also significant (STRGBA 1995 in DWR 2003c). Lesser recharge occurs as a result of subsurface flows originating in the mountains and foothills along the east side of the subbasin, losses from minor streams and from percolation of direct precipitation.

2.8.3 Turlock Groundwater Subbasin

The Turlock Subbasin is bordered by the Tuolumne River to the north, the SJR to the west, and the Merced River to the south. The subbasin is located under the urban centers of Ceres, south Modesto, Turlock, and several smaller communities, which use groundwater for a large portion of their drinking water supply.

The subbasin encompasses approximately 349,000 acres. There are approximately 269,000 acres of irrigated land in the subbasin, with approximately 56 percent of these acres potentially being supplied with surface water from TID and a small portion from Merced ID (Table 9-5).

Groundwater levels in this subbasin decreased at approximately 0.25 foot/year during 1970–2000, with groundwater declines coinciding with dry periods and stabilization and recovery coinciding with wet periods. Since 1982, water level declines have been more severe in the eastern portion of the subbasin; however, from 1970 to 1982, water level declines were more severe in the western portion of the subbasin (DWR 2003d).

Groundwater recharge primarily comes from deep percolation of surface water used for irrigation. Additional recharge also occurs as a result of precipitation, seepage from Turlock Lake, lateral groundwater inflow from the east, and upward inflow from deep geologic fractures. The net effect of the groundwater interaction with the Tuolumne and Merced Rivers and the SJR was estimated to be negative, with more groundwater discharging to the rivers in the western portion of the subbasin than seeping from the upstream portions of the Tuolumne and Merced Rivers in the eastern portion of the subbasin (Turlock Groundwater Basin Association 2008).

2.8.4 Merced Groundwater Subbasin

The Merced Subbasin is bordered by the Merced River to the north, the SJR to the west, and partially by the Chowchilla River to the south. The subbasin is located under the urban centers of Atwater, Livingston, Merced, and several smaller communities, which use groundwater for a large portion of their drinking water supply.

The subbasin encompasses approximately 491,000 acres, and approximately 55 percent (approximately 269,000 acres) is irrigated. Approximately 32 percent of these acres (86,000 acres) are potentially supplied with surface water from Merced ID (Table 9-5). Merced ID relies primarily on surface water, but also on groundwater, to fulfill customer demand throughout the irrigation season. Agricultural land outside the Merced ID is more dependent on groundwater than the agricultural land within Merced ID service boundaries.

Groundwater levels in this subbasin decreased at approximately 1 foot/year during 1970–2000 (DWR 2003e), although some other estimates show different rates of decline. Determination of the rate is dependent on the span of years evaluated because groundwater levels rise and fall in response to hydrologic conditions. Water level declines have been more severe in the eastern part of the subbasin (DWR 2015).

Recharge from rivers and creeks tends to occur more in the eastern part of the subbasin where the Merced and Chowchilla Rivers are well above the water table. In contrast, groundwater tends to be discharged to the Merced River and the SJR at the western edge of the subbasin where the rivers are close to the water table. Merced ID has been increasing groundwater recharge by taking several actions to replace groundwater use with surface water use. These actions include providing surface water to land previously inaccessible to the Merced ID conveyance system, responding more quickly to requests for surface water delivery, and starting a direct recharge project at Cressey Basin (MAGPI 2008).

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Chapter 3
Alternatives Description

3.1 Introduction

The State Water Resources Control Board (State Water Board) is considering amendments to the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan). The Porter-Cologne Water Quality Control Act requires water quality control plans (WQCP) to designate or establish the beneficial uses of water to be protected, water quality objectives that will ensure the reasonable protection of the beneficial uses, and a program of implementation designed to achieve the objectives. (Wat. Code, §§ 13050(j), 13241.)

The plan amendments[1] would include new February–June Lower San Joaquin River (LSJR) flow objectives for the protection of fish and wildlife beneficial uses and an associated program of implementation. The plan amendments would also modify the existing southern Delta water quality (SDWQ) objectives for the protection of agricultural beneficial uses and the associated program of implementation for those objectives.[2] Potential changes to the program of implementation (Appendix K, *Revised Water Quality Control Plan*) that would not result in significant or potentially significant adverse environmental effects are not discussed in detail in this recirculated substitute environmental document (SED).

The California Environmental Quality Act (CEQA) requires an environmental document such as an SED to describe a range of reasonable alternatives to a project that "would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives." (State CEQA Guidelines § 15126.6, subd. (a); Cal. Code Regs., tit. 23, § 3777, subd. (b).) An SED need not consider every conceivable alternative to a project, but instead, it "must consider a reasonable range of potentially feasible alternatives that will foster informed decision making and public participation." (State CEQA Guidelines § 15126.6, subd. (a).) An SED is not required to consider alternatives that are infeasible. (*Ibid.*)

This chapter describes: the purposes and goals[3] of the plan amendments; the LSJR and SDWQ alternatives evaluated in this SED; the No Project Alternative; and the alternatives considered but eliminated from consideration in this SED.

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[1] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

[2] This SED may refer to the proposed amendments to the southern Delta salinity objectives in the singular or plural. The use of singular or plural is immaterial to the description of the southern Delta salinity alternatives.

[3] State CEQA Guidelines Section 15124, subdivision (b), requires the lead agency to include a statement of the objectives sought by the proposed project. To avoid confusion with the term "objective" as it is used in reference to flow and water quality objectives, this document will refer to the "objectives" mentioned in Section 15124 instead as "goals."

3.2 Purposes and Goals

The 2006 Bay-Delta Plan designates beneficial uses of water, establishes water quality objectives for the reasonable protection of those beneficial uses, outlines a program of implementation for achieving the water quality objectives, and includes monitoring and special studies. It also provides recommended actions for other entities to take that will contribute to achieving the objectives. The underlying fundamental purpose and goal of the plan amendments is twofold.

- To establish flow water quality objectives during the February–June period and a program of implementation for the reasonable protection of fish and wildlife beneficial uses in the LSJR Watershed, including the three eastside, salmon-bearing tributaries.[4]
- To establish SDWQ objectives for the reasonable protection of southern Delta agricultural beneficial uses and a program of implementation to achieve the objectives.

As described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, scientific information indicates that higher flows of a more natural pattern are needed from the three eastside, salmon-bearing tributaries to the LSJR during the spring (February–June) to protect fish and wildlife beneficial uses (including San Joaquin River [SJR] Basin fall-run Chinook salmon). Therefore, in addition to the fundamental purpose and goal of the plan amendments, the purposes and goals related to the LSJR flow objectives and associated program of implementation are as follows.

1. Maintain inflow conditions from the SJR Watershed sufficient to support and maintain the natural production of viable native fish populations migrating through the Delta.
2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries—the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted.
3. Provide flows in a quantity necessary to achieve functions essential to native fishes such as increased floodplain inundation, improved temperature conditions, improved migratory conditions, and promote other conditions that favor native fishes over nonnative fishes.
4. Allow adaptive implementation of flows that will afford maximum flexibility in establishing beneficial habitat conditions for native fishes, addressing scientific uncertainty and changing conditions, developing scientific information that will inform future management of flows, and meeting biological goals, while still reasonably protecting the fish and wildlife beneficial uses.
5. Promote transparency in decision-making and provide certainty to the regulated community by expressing flow requirements for the protection of fish and wildlife as a share of the total quantity of water available for all beneficial uses.
6. In establishing flow water quality objectives to reasonably protect fish and wildlife, take into consideration all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.

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[4] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

7. Provide for the development and implementation of an appropriate monitoring and evaluation program to inform adaptive implementation of LSJR flows and future changes to the Bay-Delta Plan.
8. Provide for, and encourage, collaboration, coordination, and integration of regulatory, scientific, and management processes related to LSJR flows.

As described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, salt stress can damage crops in several different ways, including stunting growth, diminishing seedling success, and causing foliar damage, thus reducing yield of crops. Salinity levels in the southern Delta are affected primarily by the salinity of water flowing into the southern Delta from the SJR near Vernalis and evapoconcentration of salt in water that is diverted from and discharged back into southern Delta channels for agricultural purposes. Point sources of salt in the southern Delta have a small overall salinity effect. Salinity conditions are also affected by the capacity of the southern Delta water bodies to assimilate these salinity inputs. This assimilative capacity is potentially affected by hydrodynamic conditions, such as water levels and the direction and magnitude of flow in the various channels of the southern Delta. The purposes and goals related to the SDWQ objective and associated program of implementation are as follows.

1. Provide salinity conditions that reasonably protect agricultural beneficial uses of surface waters in the southern Delta.
2. In establishing salinity water quality objectives to reasonably protect agricultural beneficial uses, take into consideration all of the demands being made and to be made on waters in the southern Delta, the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.
3. Establish a salinity objective, supported by existing scientific information, that is not lower than necessary to reasonably protect the most salt sensitive crops currently grown or suitable to be grown on saline- and drainage-impaired soils in the southern Delta.
4. Maintain or improve salinity conditions in the southern Delta to comply with state and federal antidegradation policies.
5. Provide for development and implementation of monitoring and modeling studies needed to better understand the characteristics of salinity conditions in the southern Delta and the dynamics of factors controlling or contributing to those conditions.

3.3 Lower San Joaquin River (LSJR) Alternatives

The development of alternatives requires an understanding of the attributes of alternatives that could feasibly attain most of the basic objectives of the plan amendments but would avoid or substantially lessen any of the significant environmental effects. Attributes of flow objective alternatives may be described or constrained by geography, method, season and averaging period, magnitude, and other aspects of a flow regime. A regulatory program may also consider non-flow measures and adaptive management. Attributes of salinity objective alternatives may be described or constrained by geographic scope, season and averaging period, and the level of protection. The attributes of flow and salinity objectives can then be used to assess the potential for alternatives to achieve the plan amendment goals and to have potential effects, in order to determine which alternatives are feasible, and should be evaluated, and which are infeasible, and may eliminated from further consideration.

In evaluating potential amendments to the 2006 Bay-Delta Plan, the State Water Board identified key elements that would reasonably protect fish and wildlife beneficial uses in the LSJR Watershed. These key elements form the foundation of the fundamental purpose of the plan amendments:

> "To establish flow water quality objectives during the February–June period and a program of implementation for the reasonable protection of fish and wildlife beneficial uses in the LSJR watershed, including the three eastside, salmon-bearing tributaries (the Stanislaus, Tuolumne, and Merced Rivers)."

First, the State Water Board, which is the State agency responsible for protecting the State's water resources, focused on establishing flow water quality objectives because the best available science identifies flow as a major factor affecting fisheries and other instream uses of water in the Delta. The State Water Board, which is the State agency responsible for protecting the State's water resources, is best suited to using its regulatory authority to address the flow regime. Second, the State Water Board focused on SJR basin fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*), because these anadromous species are among the most sensitive to inflows from the SJR basin to the Bay-Delta. Flows that benefit these species will also generally benefit other species in the SJR Watershed. Third, the State Water Board identified the geographic scope of the plan amendments to protect the existing fishery in the LSJR Watershed—the three eastside salmon-bearing tributaries—because that portion of the watershed supports an existing fishery that can be maintained and improved. The State Water Board will consider additional measures in future Bay-Delta Plan updates to protect beneficial uses in other areas, such as the Upper SJR, when those areas are restored and can support a fishery. Finally, the State Water Board identified the February-June period as the period in which flows are most critical to support ecosystem functions such as migration.

3.3.1 Attributes of LSJR Flow Objectives

Attributes of flow objective that inform the feasibility of the LSJR alternatives and the ability of the alternatives to avoid or substantially lessen any of the significant environmental effects are: geography; method; season and averaging period; and magnitude. In addition, other considerations, such as non-flow measures and adaptive management, inform the selection of the LSJR alternatives.

Geography

The current flow objective applies only to the SJR at Vernalis. In developing the alternatives, the State Water Board considered whether alternative flow objectives would apply only to Vernalis, just as the current objective, or be extended upstream to some other location. Goals 1 and 2 of the of the plan amendments are as follows.

1. Maintain inflow conditions from the SJR Watershed sufficient to support and maintain the natural production of viable native fish populations migrating through the Delta.
2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries —the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted.

These goals support the selection of a flow alternative that includes the Stanislaus, Tuolumne, and Merced Rivers, not just Vernalis, because the expanded geographic area supports a variety of critical life history stages. For example, flows that support juvenile rearing in the tributary streams and migration through the Delta are needed to maintain the natural production of SJR fall-run Chinook salmon. Though these goals do not explicitly preclude consideration of alternative flow objectives upstream of the Merced River confluence, that area does not currently support viable native fish populations, and such alternatives would not reduce or avoid impacts. For example, such an alternative would not reduce the quantity of water needed from the Stanislaus, Tuolumne, and Merced Rivers to achieve the goals. Inclusion of the flow alternatives for the SJR upstream of the Merced River confluence would increase the adverse environmental effects of the LSJR alternatives in a larger geographic area by reducing the quantity of water available for other uses in areas that rely upon water supplies in the SJR upstream of Merced River confluence. For this reason, alternatives that considered establishing flow objectives in geographic areas other than the LSJR Watershed and the Stanislaus, Tuolumne, and Merced Rivers, were eliminated from further consideration.

Method

There are two principal methods that can be used to develop a flow objective, and that could be considered as an alternative: (1) fixed monthly flows or blocks of water that vary by water year type or other variables, or (2) a percent of unimpaired flow. Unimpaired flow is the flow that would accumulate in surface waters in response to rainfall and snowmelt, and flow downstream if there were no reservoirs or diversions to change the quantity, timing, and magnitude of flows.

The current flow objective at Vernalis is comprised of fixed monthly flows that vary by water year type--higher fixed flows in wet years, and lower fixed flows in dry years. There are five water year types. The relative quantities of water required vary by month and year, and are intended to provide more flow when needed to achieve certain functions such as the outmigration of salmon during an April/May pulse flow. Fixed monthly flows could, alternatively, be established that are not linked to hydrology. These would be purely functional flows that are needed to benefit fish and wildlife but are not tied to the available water supply that is determined by precipitation. LSJR alternatives that are not tied to hydrology were eliminated from any further consideration because they do not mimic natural hydrographic conditions or consider other beneficial uses of water and would, therefore, be in conflict with goals 2, 5, and 6.

2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries—the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted.
5. Promote transparency in decision-making and provide certainty to the regulated community by expressing flow requirements for the protection of fish and wildlife as a share of the total quantity of water available for all beneficial uses.
6. In establishing flow water quality objectives to reasonably protect fish and wildlife, take into consideration all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.

Alternatively, flows can be tied directly to unimpaired flow by establishing a flow objective based on a percentage of unimpaired flow. LSJR alternatives tied directly to unimpaired flow achieve goals 2 and 3, among others.

2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries—the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted.
3. Provide flows in a quantity necessary to achieve functions essential to native fishes such as increased floodplain inundation, improved temperature conditions, improved migratory conditions, and promote other conditions that favor native fishes over nonnative fishes.

Fixed monthly flows that vary by month and water year type (similar in method to current flow objectives), or blocks of water that vary by year type, could also be used to achieve these goals instead of flows tied directly to unimpaired flow. Many of the LSJR alternatives suggested by commenters are monthly flows that vary by month and water year type. All of these other LSJR alternatives, however, can be represented by a percent of unimpaired flow quantity, so long as the quantity of water represented by a percent of unimpaired flow is large enough to apportion and shape as needed to achieve fish and wildlife protection goals. These other fixed monthly flow alternatives are discussed in Section 3.3.9, *LSJR Alternatives Considered but Eliminated from Further Evaluation*, and the total volumes of water are compared with the alternatives considered in this SED. In general, however, varying the methodology does not reduce or avoid potentially significant environmental effects, which is the relevant consideration in evaluating the LSJR alternatives.

Season and Averaging Period

The current flow objective is applicable only at Vernalis, and varies by month and year type for the February–June period. There is also an October flow objective. The flow objectives are established as monthly average flows, meaning that flows can vary within the month so long as the average monthly flow rate achieves the flow objective. New flow objectives could be established for specific months, seasons, or every month of the year. Averaging periods could be monthly, or longer or shorter duration. Goal 2 informs both the seasonality and averaging period for LSJR alternatives.

2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries—the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted

Although the State Water Board identified the February-June period as the period in which flows are most critical to support ecosystem functions such as migration, other time periods are also important for other life stages. These other time periods include the fall, which is important for providing a migration cue for returning salmon, and summer, which is important for steelhead.

Magnitude

Goal 2 also directly informs the development of alternatives with regard to the magnitude of flows. Magnitude and total quantity of flow are the principal considerations in the development and selection of alternatives because the total quantity of water provided for the protection of fish and wildlife must be considered in relation to goals 5 and 6, in addition to the other goals.

5. Promote transparency in decision-making and provide certainty to the regulated community by expressing flow requirements for the protection of fish and wildlife as a share of the total quantity of water available for all beneficial uses.
6. In establishing flow water quality objectives to reasonably protect fish and wildlife, take into consideration all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.

Alternatives should therefore include quantities of water that are big enough to achieve the fish and wildlife protection goal, but are not so big such that they would have an unreasonable effect on other beneficial uses of water. These constraints allow for the determination of: (1) a lower bound (representing a relatively small quantity of water), below which there could be no reasonable expectation that fish and wildlife protection goals will be achieved; and (2) an upper bound (representing a relatively large quantity of water) beyond which an alternative would have an unreasonable effect on other beneficial uses of water.

Other Considerations

Flow objectives are intended to provide the conditions needed to reasonably protect the fish and wildlife beneficial uses. Goals 1, 2, and 3, explicitly identify flows as a necessary element of alternatives.

1. Maintain inflow conditions from the SJR Watershed sufficient to support and maintain the natural production of viable native fish populations migrating through the Delta.
2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries—the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted.
3. Provide flows in a quantity necessary to achieve functions essential to native fishes such as increased floodplain inundation, improved temperature conditions, improved migratory conditions, and promote other conditions that favor native fishes over nonnative fishes.

It may be possible to achieve the ecosystem functions identified in goal 3, in part, through the application of non-flow measures such as temperature control and increased floodplain habitat. Temperature and floodplain improvements could occur without the need for as much water, and could directly improve conditions for fish and wildlife without relying entirely on flow. Nonetheless, flow is an essential element for protecting fish and wildlife beneficial uses.

Another consideration in developing alternatives is whether or not to allow adaptive implementation. A flow objective with no adaptive implementation would have to be met exactly as prescribed, without adjustment. Adaptive implementation, in contrast, allows a flow objective to be adjusted based on other information, thus allowing flexibility. LSJR alternatives with adaptive implementation achieve goal 4.

4. Allow adaptive implementation of flows that will afford maximum flexibility in establishing beneficial habitat conditions for native fishes, addressing scientific uncertainty and changing

conditions, developing scientific information that will inform future management of flows, and meeting biological goals, while still reasonably protecting the fish and wildlife beneficial uses.

Alternatives that do not include adaptive implementation were not considered because they would require rigid adherence with flows that may not be optimal based on new information or changed conditions. Alternatives with no adaptive implementation would therefore also conflict with goal 6 because more water than is needed to reasonably protect fish and wildlife would have to be provided even in light of new information or changed conditions.

3.3.2 LSJR Alternatives Considered

The State Water Board considered a range of reasonable alternatives that would feasibly attain most of the basic goals of the plan amendments, discussed in Section 3.2, *Purposes and Goals*, but would avoid or substantially lessen any of the significant environmental effects of the plan amendments. Because the indirect effects of the plan amendment are primarily associated with increased instream flows or reductions in water supply available for diversion, this SED focuses on alternatives that evaluate a range of flows, based on unimpaired flow, with a lower and upper bound. The lower bound represents the minimum quantity of water at which there is a reasonable expectation that fish and wildlife protection goals will be achieved, although at this level, it may require other actions, such as non-flow measures. The upper bound represents the maximum quantity of water beyond which an alternative would have an unreasonable effect on other beneficial uses of water, and would therefore not be feasible. Each LSJR alternative also includes an adaptive range that has the effect of lessening the impact of the alternatives.

This SED evaluates four alternatives for LSJR flow requirements during the February–June time frame, including the LSJR Alternative 1 (No Project Alternative) and three other LSJR alternatives (LSJR Alternatives 2, 3, and 4).

LSJR Alternatives 2, 3, and 4 are comprised of narrative and numeric flow objectives and an associated program of implementation. The objectives will require flows below the rim dams[5] on the Stanislaus, Tuolumne, and Merced Rivers, and the mainstem of the LSJR between its confluence with the Merced River and downstream to Vernalis. The narrative objective calls for the following:

> "Maintain inflow conditions from the San Joaquin River Watershed to the Delta at Vernalis, sufficient to support and maintain the natural production of viable native San Joaquin River Watershed fish populations migrating through the Delta. Inflow conditions that reasonably contribute toward maintaining viable native migratory San Joaquin River fish populations include, but may not be limited to, flows that more closely mimic the natural hydrographic conditions to which native fish species are adapted, including the relative magnitude, duration, timing, and spatial extent of flows as they would naturally occur. Indicators of viability include population abundance, spatial extent, distribution, structure, genetic and life history diversity, and productivity."

In addition to the narrative objective, there are numeric flow objectives from February–June. This is the element of the flow objective where LSJR Alternatives 2, 3, and 4 have different lower and upper bounds of the adaptive range:

> "A percent of unimpaired flow between a lower and upper limit from each of the Merced, Tuolumne, and Stanislaus Rivers shall be maintained from February through June."

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[5] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

The final element of the flow objective requires, the same for all alternatives, requires a base flow at Vernalis:

> "Notwithstanding the above unimpaired flow requirement, a minimum base flow value between 800-1,200 cfs [cubic feet per second], inclusive, at Vernalis, shall be maintained at all times."

Each LSJR alternative evaluates a different range of flows.

- LSJR Alternative 2 evaluates a range between 20 and 30 percent, with 20 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 3 evaluates a range between 30 and 50 percent, with 40 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 4 evaluates a range between 50 and 60 percent, with 60 percent as the starting percentage of unimpaired flow in the program of implementation.

Ultimately, however, the State Water Board, in exercising its authority and responsibilities, may select a range within the LSJR alternatives analyzed that is consistent with the requirements of applicable law, including CEQA and the Porter-Cologne Water Quality Control Act. In other words, the Board may select a percent of unimpaired flow anywhere between the 20 and 60 percent range evaluated in this SED. Likewise, the Board may implement the range with a different starting percentage of unimpaired flow in the program of implementation.

The program of implementation includes specific flow requirements and other measures to implement the objectives. Specifically, LSJR Alternatives 2, 3, and 4 implement the numeric flow objective by requiring 20 percent, 40 percent, and 60 percent, respectively, of unimpaired flow, based on a minimum 7-day average, from each of the Stanislaus, Tuolumne and Merced Rivers and allow for adaptive adjustments within the numeric water quality objective range for each alternative. The program of implementation provides that the State Water Board will fully implement the February–June LSJR flow objectives by 2022 through water right actions and water quality actions, including Federal Energy Regulatory Commission (FERC) hydropower licensing processes. These actions are necessary because the amendments to the 2006 Bay-Delta Plan are not self-implementing.

These unimpaired flow percentages, 20, 40, and 60 percent, were selected as alternatives to capture a range of potential flow alternatives that the State Water Board may implement, thus allowing an examination of alternatives that would feasibly obtain most of the goals of the plan amendments while avoiding or substantially lessening any significant impacts. The alternative with the lowest flow, LSJR Alternative 2 is 20 to 30 percent unimpaired flow, and was selected to bracket the low end of flows under current conditions because it potentially could have fewer impacts on the environment than higher flows.[6] LSJR Alternative 3 is 30 to 50 percent of unimpaired flow, which represents a mid-point for the analysis, and would be more likely to both meet most of the goals of the plan amendments while potentially having fewer impacts on the environment. LSJR Alternative 4 has the highest level of flow, with 50 to 60 percent of unimpaired flow. The State Water Board's 2010 report, *Development of Flow Criteria for the Sacramento–San Joaquin Delta Ecosystem*, determined that approximately 60 percent of unimpaired flow at Vernalis from February–June would be fully protective of fish and wildlife beneficial uses in the three eastside tributaries and LSJR when considering flow alone. This level of unimpaired flow, however, also represents the

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[6] Flows in the Stanislaus, Tuolumne, and Merced Rivers and the SJR at Vernalis had median values of 40, 21, 26, and 29 percent of February–June unimpaired flow, respectively, for water years 1986–2009.

upper bound above which there would be unacceptably high adverse effects on water supply and temperature control.

3.3.3 Adaptive Implementation

The unimpaired flow objective does not have to be implemented in a way that requires rigid adherence with a fixed percent of unimpaired flow. LSJR Alternatives 2, 3, and 4 include an adaptive implementation element. This adaptive implementation element allows for flows under each alternative to be "shaped" or shifted in time to provide more functionally useful flows and to respond to changing information and conditions. Functionally useful flows achieve a specific function such as increased habitat, more optimal temperatures, or a migration cue. The unimpaired flow requirement also does not need to remain at one fixed percent, but may be adaptively implemented within a range of unimpaired flow in response to changing information, and changing conditions. Each of the three LSJR alternatives is intended to provide the flexibility to be achieved through adaptive implementation. Each of the three tributaries may be managed differently, with respect to the percent of unimpaired flow and the specific adaptive implementation, so long as the adaptive implementation in the three rivers is coordinated.

The adaptive implementation element of the flow proposal consists of a defined adaptive implementation process that allows the magnitude and timing of flows to be adjusted in a number of ways, within a prescribed range of flows, if scientific information supports that such changes would continue to support and maintain the natural production of the viable native fish LSJR fish populations migrating through the Delta. Adaptive implementation achieves one of the principal goals for flow objectives.

4. Allow adaptive implementation of flows that will afford maximum flexibility in establishing beneficial habitat conditions for native fishes, addressing scientific uncertainty and changing conditions, developing scientific information that will inform future management of flows, and meeting biological goals, while still reasonably protecting the fish and wildlife beneficial uses.

Adaptive Implementation also achieves these related goals.

- Quickly respond to changing information and changing conditions, including changes in flow patterns as a result of climate change.
- Minimize adverse water temperature effects.
- Allow for adaptive management and conducting of scientific experiments.

Adaptive implementation could also be used to optimize flows to achieve the objectives while allowing for consideration of other beneficial uses, such as agricultural, municipal, and recreational uses, provided that these other considerations do not reduce intended benefits to fish and wildlife and that requirements are met. Adaptive implementation allows for flows to be reduced to the low end of the range as long as these reductions do not reduce benefits to fish and wildlife and, thus, could have the effect of lessening the environmental impacts associated with higher flow alternatives. The State Water Board may approve adaptive adjustments to the flow requirements as forth in (1)–(4) below if information produced through the monitoring and review processes in the program of implementation, or other best available scientific information, indicates that the change for the period at issue will: (a) be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta, and (b) meet any existing biological goals approved by the State Water Board. The Stanislaus, Tuolumne, and Merced Working

Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the methods, the STM Working Group, and the approval process are included in Appendix K, *Revised Water Quality Control Plan*.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are generally described below; they are described in Sections 3.3.5 through 3.3.7 as they relate to each LSJR alternatives.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.

2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.

3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Appendix K, for further details.

4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

Any of the adjustments in (1)–(4) above may be made independently of each other or combined. The adjustments in (1), (2), and (3) may also be made independently on each of the Stanislaus, Tuolumne, and Merced Rivers, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses. Experiments may also be conducted within the adaptive adjustments in (1)–(4), subject to the approvals provided therein, in order to improve scientific understanding of needed measures for the protection of fish and wildlife beneficial uses, such as the optimal timing of required flows. Any experiment shall be coordinated with the San Joaquin River Monitoring and Evaluation Program (SJRMEP), described below, and identify the scientific uncertainties to be addressed and the actions that will be taken to reduce those uncertainties, including monitoring and evaluation.

Although framed as February– June flow objectives, the range of alternatives captures the entire feasible quantity of water that could be used to reasonably protect fish and wildlife in the LSJR year round. As shown in Table 3-1, approximately 80 percent of the annual volume of unimpaired flow occurs in February–June (based on 1984–2009 unimpaired flow data from Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*). This means that LSJR Alternative 4 evaluates the effects of directing approximately 48 percent of mean annual flows towards the protection of fish and wildlife (60 percent multiplied by 80 percent). The impacts assessment of LSJR Alternative 4 shows that redirecting this quantity of water at the current level of water development would cause large adverse effects on water supply and temperature control. The adaptive element of the LSJR alternatives means that up to 25 percent of the February–June flows can be shifted to time periods after June, thus assuring that there will be no adverse effects on fisheries, including temperature, that would otherwise result from implementation of the February–June flow requirements. The combination of an alternative that requires 60 percent of February –June unimpaired flows, in combination with adaptive implementation, which allows shifting of up to 25 percent of this flow volume means that this SED has evaluated all feasible alternatives with regard to the quantity of water consistent with the goal to "take into consideration all of the demands being made and to be made on waters in the LSJR" (goal 6).

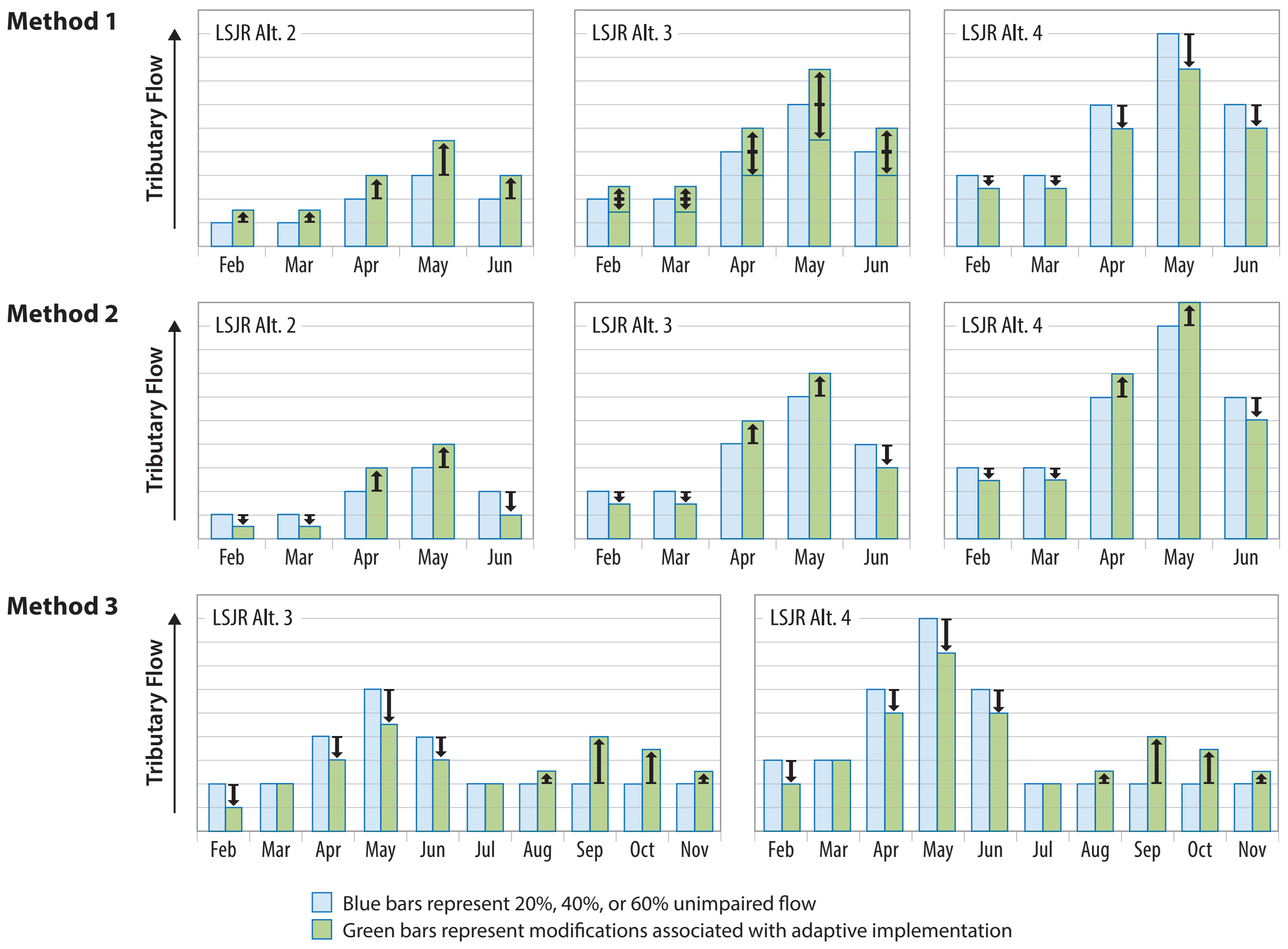
Table 3-1. February–June Unimpaired Flow as a Percent of Annual Unimpaired Flow on the Three Eastside Tributaries

	Feb–June Unimpaired Flow as a % of the Annual Unimpaired Flow		
Averaged for:	Stanislaus	Tuolumne	Merced
All Years	80	79	80
Wet	73	71	72
Above Normal	83	82	85
Below Normal	82	80	80
Dry	84	84	85
Critical	85	85	85

The specific constraints on the use of adaptive implementation vary between LSJR Alternatives 2, 3, and 4 because the alternatives have different starting percentages and ranges. These differences are identified in the description of alternatives below. Also, see Figure 3-1 which provides conceptual illustrations of the adaptive implementation methods for each of the LSJR alternatives.

Applicability of Methods for Each LSJR Alternative

	LSJR Alt. 1	LSJR Alt. 2	LSJR Alt. 3	LSJR Alt. 4
Method 1	N/A	✓	✓	✓
Method 2	N/A	✓	✓	✓
Method 3	N/A	N/A	✓	✓
Method 4	N/A	✓	✓	✓



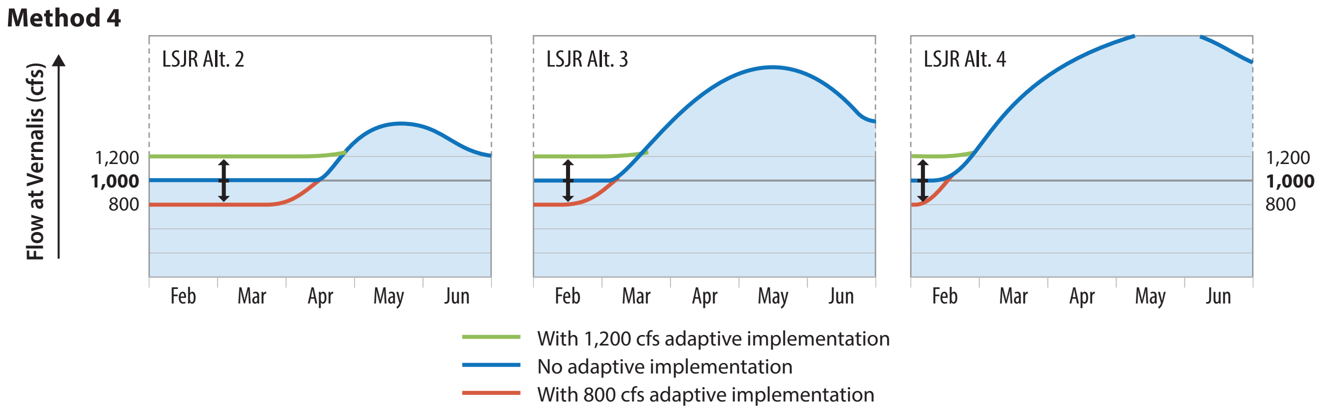


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Figure 3-1
Conceptual Illustrations of Adaptive Implementation Methods for each LSJR Alternative

3.3.4 LSJR Alternative 1: No Project Alternative

California Code of Regulations, Title 14, Section 15126.6, Subdivision (e), requires evaluation of a no project alternative and its impacts. The purpose of a no project alternative is to compare the impacts of approving a project with the impacts of not approving a project. When a project is the amendment of a regulatory plan, such as the 2006 Bay-Delta Plan, the no project alternative will be the continuation of the existing plan into the future. In evaluating the impacts of a no project alternative, a lead agency should consider what is reasonably expected to occur in the foreseeable future.

LSJR Alternative 1 is the No Project Alternative (see Section 3.4.3, *SDWQ Alternative 1: No Project Alternative*). The No Project Alternative assumes continued implementation of, and full compliance with, the 2006 Bay-Delta Plan, as implemented through State Water Board's Water Right Decision 1641 (D-1641). The No Project Alternative focuses on efforts related to the implementation of Vernalis flow objectives and a southern Delta salinity objective because these objectives are the ones proposed to be amended. The Vernalis flow objectives were first established in the 1995 Bay-Delta Plan to protect fish and wildlife beneficial uses. These objectives include the minimum monthly flow rates for fish and wildlife beneficial uses during specific times of the year, as presented in Table 3 of the 2006 Bay-Delta Plan and implemented through D-1641. In D-1641, the State Water Board assigned compliance with these minimum flows on the SJR at Vernalis to the U.S. Bureau of Reclamation (USBR). When the State Water Board subsequently amended the Bay-Delta Plan in 2006, it approved an interim flow regime through the Vernalis Adaptive Management Program (VAMP) experiment, as proposed in the San Joaquin River Agreement (SJRA), in lieu of meeting the April–May pulse flow objective (as presented in Table 3 of the 2006 Bay Delta Plan).

No Project Alternative conditions differ from the baseline because the Vernalis flow objectives in Table 3 of the 2006 Bay-Delta Plan have not been fully implemented and are not part of the baseline because of implementation of the SJRA and VAMP. The VAMP flows, which are generally lower than the Table 3 flows in the 2006 Bay-Delta Plan, are thus included in the baseline. During VAMP, a portion of the flows needed to comply with VAMP came from the three eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers), even though the 2006 Bay-Delta Plan and D 1641 do not contain numeric or narrative flow requirements specific to these rivers. However, the No Project Alternative does not include VAMP flows because that experimental flow regime concluded in 2011. The No Project Alternative and the baseline both include the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) flow requirements on the Stanislaus River, FERC requirements on the Tuolumne and Merced Rivers, and the Davis Grunsky requirements on the Merced River.

The No Project Alternative assumes that the flows would continue to be the responsibility of USBR and that the objectives would be met with additional releases from New Melones Reservoir on the Stanislaus River. There are other possible ways that compliance with the objectives could be achieved, but it is speculative to identify which other measures, or combination of measures, would be used. For example, the flow objective could be achieved by a combination of releases from New Melones Reservoir and other actions (e.g., water purchases and transfers among different water users and other upstream SJR actions [such as SJR Restoration Program[7] flows]). However, these other actions are difficult to predict or quantify. The analytical approach used here evaluates increased releases from New Melones Reservoir to meet the objectives because such releases could be the primary method by which the Vernalis flow objectives and southern Delta salinity objective

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[7] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future.

would be achieved. Focusing the evaluation on New Melones Reservoir releases affords an evaluation of maximum potential water supply impacts compared to assuming that increases in Vernalis flow would be distributed among the tributaries.

The No Project Alternative also assumes the continuation of the southern Delta salinity objective for agricultural beneficial uses, as identified in Table 2 of the 2006 Bay-Delta Plan, and full compliance with these objectives as implemented through D-1641 (see Section 3.4.3, *SDWQ Alternative 1: No Project Alternative*). Under D-1641, compliance with the numeric salinity objective on the SJR at Vernalis (station C-10) is the obligation of USBR. Compliance with the numeric salinity objective at the three interior southern Delta compliance stations—SJR at Brandt Bridge (station C-6), Old River near Middle River (station C-8), and Old River at Tracy Road Bridge (station P-12)—is the combined obligation of USBR and the California Department of Water Resources (DWR).

Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, evaluate the potential impacts of the No Project Alternative. Appendix D provides the modeling assumptions and technical analysis considered in Chapter 15. LSJR Alternative 1 and SDWQ Alternative 1 are evaluated together as the No Project Alternative because continuation of the 2006 Bay-Delta Plan would require compliance with the Vernalis flow objectives and southern Delta salinity objective. Appendix D quantifies the amount of water needed to meet both objectives in the 2006 Bay-Delta Plan.

3.3.5 LSJR Alternative 2

LSJR Alternative 2 implements the 20–30 percent numeric flow water quality objective range by initially requiring maintenance of 20 percent of unimpaired flows at the confluences of each of the Stanislaus, Tuolumne, and Merced Rivers with the SJR from February–June based on a minimum 7-day running average. As described above in Section 3.3.3, *Adaptive Implementation*, the flow requirements could be adaptively adjusted in the same manner for LSJR Alternatives 2, 3, and 4. The following discussion describes aspects of adaptive implementation as specifically applied to LSJR Alternative 2.

1. Adjust the unimpaired flow objective within a range of 20 percent to 30 percent, inclusive.
2. Manage the February–June percent of unimpaired flow as a total volume of water and release the water on an adaptive schedule during that period where scientific information indicates a flow pattern different from that which would occur by tracking the unimpaired flow percentage, would better protect fish and wildlife beneficial uses. Applying this method, the total volume of water released would be the same as LSJR Alternative 2 without adaptive implementation; however the rate could vary from the actual (7-day running average) unimpaired flow rate and the volume for each month could vary.
3. Unlike LSJR Alternatives 3 and 4, a portion of the total February–June unimpaired flow volume may not be held and released after June in order to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February–June flow requirements.
4. The minimum required LSJR base flow objective for February–June of 1,000 cfs, based on a minimum 7-day running average, at Vernalis may be adjusted to a value between 800 and 1,200 cfs.

3.3.6 LSJR Alternative 3

LSJR Alternative 3 implements the 30–50 percent numeric flow water quality objective range by initially requiring maintenance of 40 percent of unimpaired flows at the confluences of each of the Stanislaus, Tuolumne, and Merced Rivers with the SJR from February–June based on a 7-day minimum running average. As described above in Section 3.3.3, *Adaptive Implementation*, the flow requirements could be adaptively adjusted in the same manner for LSJR Alternatives 2, 3, and 4. The following discussion describes aspects of adaptive implementation as specifically applied to LSJR Alternative 3.

1. Adjust the minimum unimpaired flow objective within a range of 30 percent to 50 percent.
2. Implementing this method would allow an increase or decrease of up to 10 percent in the February–June 40 percent minimum unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent).
3. Manage the February–June percent of unimpaired flow as a total volume of water and release the water on an adaptive schedule during that period where scientific information indicates a flow pattern different from that which would occur by tracking the unimpaired flow percentage, would better protect fish and wildlife beneficial uses. Applying this method, the total volume of water released would be the same as LSJR Alternative 3 without adaptive implementation; however the rate could vary from the actual (7-day running average) unimpaired flow rate and the volume for each month could vary.
4. Allow a portion of the total February–June unimpaired flow volume to be held and released after June in order to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February–June flow requirements. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June.
5. The minimum required LSJR base flow objective for February–June of 1,000 cfs, based on a minimum 7-day running average, at Vernalis may be adjusted to a value between 800 and 1,200 cfs.

3.3.7 LSJR Alternative 4

LSJR Alternative 4 implements the 50–60 percent numeric flow water quality objective range by initially requiring maintenance of 60 percent of unimpaired flows at the confluences of each of the Stanislaus, Tuolumne, and Merced Rivers with the SJR from February–June based on minimum a 7-day running average. As described above in Section 3.3.3, *Adaptive Implementation*, the flow requirements could be adaptively adjusted in the same manner for LSJR Alternatives 2, 3, and 4. The following discussion describes aspects of adaptive implementation as specifically applied to LSJR Alternative 4.

1. Adjust the minimum unimpaired flow objective within a range of 50 percent to 60 percent.
2. Manage the February–June percent of unimpaired flow as a total volume of water and release the water on an adaptive schedule during that period where scientific information indicates a flow pattern different from that which would occur by tracking the unimpaired flow percentage, would better protect fish and wildlife beneficial uses. Applying this method, the total volume of

water released would be the same as LSJR Alternative 4 without adaptive implementation; however the rate could vary from the actual (7-day running average) unimpaired flow rate and the volume for each month could vary.

3. Allowing a portion of the total February–June unimpaired flow volume to be held and released after June in order to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February–June flow requirements. If the requirement is 50 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June.
4. The minimum required LSJR base flow objective for February–June of 1,000 cfs, based on a minimum 7-day running average, at Vernalis may be adjusted to a value between 800 and 1,200 cfs.

3.3.8 Common Elements of LSJR Alternatives

The following elements of the LSJR alternatives are the same for LSJR Alternatives 2, 3, and 4.

- Implementing entity and biological goals.
- Planning, monitoring, and reporting.
- State of emergency provisions.
- Non-flow measures.

Implementing Entity and Biological Goals

The State Water Board will establish the STM Working Group to assist with implementation, monitoring and assessment activities for the LSJR flow objectives. The STM Working Group will be comprised of representatives from the State Water Board; California Department of Fish and Wildlife (CDFW); NMFS; United States Fish and Wildlife Service (USFWS); water users on the Stanislaus, Tuolumne, and Merced Rivers; and any other representatives deemed appropriate by the Executive Director. The STM Working Group or State Water Board staff as necessary, will, in consultation with the Delta Science Program, develop specific measures necessary to implement the February–June LSJR flow requirements and assess their effectiveness. The STM Working Group, or State Water Board staff as necessary, will also, in consultation with the Delta Science Program, develop proposed procedures for allowing the adaptive adjustments to the February–June flow requirements.

The program of implementation requires the development of biological goals that can be used to demonstrate the reasonable protection of LSJR fish and wildlife beneficial uses, evaluate the effectiveness of the program of implementation, and to inform adaptive implementation. These biological goals will be developed by the STM Working Group or State Water Board staff, as necessary. Based on the STM's recommendations and input from other interested persons, the State Water Board will make a final determination regarding the biological goals that will be used to evaluate the effectiveness of the program of implementation. Once developed, those biological goals may be modified by the State Water Board based on new information developed through the monitoring and evaluation activities described below or other new sources of scientific information. Biological goals will be developed specifically for LSJR salmonids for abundance; productivity as measured by population growth rate; genetic and life history diversity; and population spatial extent, distribution, and structure. It is expected that the biological goals for the LSJR will be incorporated into the water rights implementation of the flow objectives. In this way, the biological goals will be one of the tools that will guide the specific flow percent that is required within the adaptive range.

Planning, Monitoring, and Reporting

A comprehensive monitoring, special studies, evaluation, and reporting program is necessary to determine compliance with the LSJR flow objectives, inform adaptive implementation, investigate the technical factors involved in water quality control, and identify potential needed future changes to the LSJR flow objectives, including flows for other times of the year. The State Water Board will require annual and comprehensive monitoring, evaluation, and reporting, as part of the SJRMEP, including:

1. Monitoring, special studies, and evaluations of the effects of flow and other factors on the viability of native LSJR Watershed fish populations throughout the year, including assessment of abundance, spatial extent (or distribution), diversity (both genetic and life history), and productivity.
2. Consideration of recommendations from entities with relevant Central Valley monitoring plans to improve standardization of methods, including the quantification of bias and precision of population estimates.
3. Regular external scientific review of monitoring, evaluation, and reporting.

Monitoring under this program would be integrated and coordinated with new and ongoing monitoring and special studies programs in the LSJR, including federal BO requirements, FERC licensing proceedings for the Merced and Tuolumne Rivers, Central Valley Regional Water Board requirements, and the Delta Science Program. The SJRMEP consists of annual and comprehensive monitoring and reporting.

To inform the next year's operations and other activities, the State Water Board will require preparation and submittal of an annual report to the State Water Board by December 31 of each year. The annual report shall describe implementation of flows, including any flow shifting done pursuant to the annual adaptive operations plan, monitoring and special studies activities, and implementation of other measures to protect fish and wildlife during the previous water year, including the actions by other entities identified in this program of implementation. The annual report shall also identify any deviations from the annual adaptive operations plan and describe future special studies. The State Water Board may hold public meetings to receive and discuss the annual report.

Additionally, every 3 to 5 years following implementation of this update to the Bay-Delta Plan, the State Water Board will require preparation and submittal of a comprehensive report that, in addition to the requirements of annual reporting, reviews the progress toward meeting the biological goals and identifies any recommended changes to the implementation of the flow objectives. The comprehensive report and any recommendations shall be peer-reviewed by an appropriate independent science panel, which will make its own conclusions and recommendations. The State Water Board will hold public meetings to consider the comprehensive report, technical information, and conclusions or recommendations developed through the peer review process. This information will be used to inform potential adaptive changes to the implementation of the flow objectives and, as appropriate, future potential changes to the Bay-Delta Plan.

In summary, the program of implementation for LSJR flow objectives identifies the following information, plans, and reports that must prepared and submitted to the State Water Board or its Executive Director for approval.

- Biological goals—one time preparation, but can be modified thereafter; to be considered for approval within 180 days after Office of Administrative Law (OAL) approval of the amendments to Bay-Delta Plan.
- Measures to achieve, monitor, and evaluate compliance with the flow objectives—one time preparation and submittal; to be considered for approval within 180 days after OAL approval of the amendments to the Bay-Delta Plan.
- Adaptive Methods Procedures—one time preparation and submittal, to be considered for approval within 1 year after OAL approval of the amendments to the Bay-Delta Plan.
- Annual Adaptive Operations Plan—due January 10 each year.
- Annual Report on Implementation Activities—due December 31 each year.
- Comprehensive Review of Implementation Actions—due every 3 to 5 years.

State of Emergency Change Provision

The current drought has highlighted the need to adjust requirements in water rights that implement the current Bay-Delta standards during emergencies. The flow proposal therefore includes a provision to adjust flows for a state of emergency, such as the current drought emergency. Under this emergency element of the flow proposal, the State Water Board, at its discretion or at the request of any affected responsible agency or person, may authorize a temporary change to the implementation of the LSJR flow objectives if the State Water Board determines that either: (1) there is an emergency as defined by CEQA (Pub. Resources Code, § 21060.3), or (2) the Governor of the State of California or a local governing body has declared a state or local emergency pursuant to the California Emergency Services Act. (Gov. Code, § 8550 et seq.) Before authorizing any temporary change, the State Water Board must find that measures will be taken to reasonably protect the beneficial use in light of the circumstances of the emergency.

Non-Flow Measures

The program of implementation for the flow proposal recommends and encourages the development of non-flow measures to assist in further improving protections for fish and wildlife beneficial uses. This is intended to provide guidance to the entities that will be responsible for attainment of flow objectives, and other entities, as regarding non-flow that are complementary to the LSJR flow objectives and that may help to achieve the overarching goal of supporting and maintaining the natural production of viable native LSJR Watershed fish populations. Increased flows, however, remain the principal means of compliance with the LSJR flow objectives. As discussed above, adaptive adjustments to the range of flows may be made if certain requirements are met, which allows for consideration of benefits associated with the non-flow measures, but the lower number of the adaptive range still represents the minimum required flow. In other words, some level of flow is always required.

The following actions are non-flow measures that can be used to improve conditions for fish and wildlife in a manner that may support a change in the flows within the adaptive range, thus lessening the significant effects of the alternatives that occur as a result of reduced water availability for diversions. These recommended actions, together with the coordinated monitoring and adaptive implementation described above, are expected to improve habitat conditions that benefit native fish and wildlife, or are expected to improve related science and management within the LSJR Watershed. The following actions are recommended for evaluation and subsequent implementation.

- Restore, enhance, and protect floodplain and riparian habitat.
- Reduce vegetation disturbing activities in floodplains and floodways, where safe and appropriate.
- Provide and maintain coarse sediment for salmonid spawning and rearing.
- Enhance in-channel complexity.
- Improve reservoir operations and/or physical structures to maintain adequate water temperature conditions.
- Expand fish screening.
- Improve fish passage above dams.
- Improve fish and water barrier programs.
- Reduce predation and competition by nonnative fish.
- Reduce invasive species.

Allowance for and implementation of these non-flow measures achieve the goal of taking “into consideration all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries” (goal 6) by allowing measures other than flow to help achieve the overarching goal of supporting and maintaining the natural production of viable native LSJR Watershed fish populations.

3.3.9 LSJR Alternatives Considered but Eliminated from Further Evaluation

CEQA requires identification of any alternatives that were considered by the lead agency but were rejected as infeasible during the scoping process with a brief explanation of the reasons underlying the lead agency’s determination. (State CEQA Guidelines, § 15126.6, subd. (c).) Among the factors that may be used to eliminate alternatives from detailed consideration are: “(i) failure to meet most of the basic project objectives, (ii) infeasibility, or (iii) inability to avoid significant environmental impacts.” (*Ibid.*)

This section summarizes alternatives that were considered by the State Water Board and eliminated from detailed consideration. It includes a discussion of suggestions that were received from the public during the comment periods associated with the February 13, 2009 notice of preparation and the April 1, 2011 revised notice of preparation. This section also includes discussion of flow recommendations received during the process of preparing the August 2010 State Water Board staff report entitled *Development of Flow Criteria for the Sacramento–San Joaquin Delta Ecosystem* (State Water Board 2010). These potential alternatives were evaluated for their ability to meet most of the underlying fundamental purposes and goals of the plan amendments, feasibility, and ability to avoid significant effects on the environment.

3.3.10 LSJR Flow Objectives and Program of Implementation

Fixed Monthly Flow-Based Programs of Implementation

Several commenters suggested the State Water Board consider fixed monthly flow objectives similar to the current flow objectives, that vary by water year type and month instead of using an unimpaired flow approach.

As detailed in Appendix C, *Technical Report on the Scientific Basis Alternative for San Joaquin River Flow and Southern Delta Salinity Objectives*, retaining the spatial and temporal attributes of the natural flow regime is important in protecting a wide variety of ecosystem processes. The historical practice of developing fixed monthly flow objectives to be met from limited sources has been shown to be less than optimal in protecting fish and wildlife beneficial uses in the SJR Basin. Accordingly, to preserve the attributes of the flow regime to which native SJR Basin fish and wildlife have adapted and that are believed to be generally protective of the current beneficial uses, the flow requirements in the program of implementation are expressed as a percentage of unimpaired flow (e.g., 40 percent of unimpaired flow). However, if specific information indicates that more fixed flows would be more protective of fish and wildlife, the adaptive management provisions of LSJR Alternatives 2, 3, and 4 could allow for such an approach to be implemented, provided that the required amount of flow is less than or equal to that of the LSJR alternatives. To assess whether this would be possible for the specific flow recommendations that the State Water Board received, an analysis was conducted to compare the flow exceedance curves for LSJR Alternatives 2, 3, and 4 with the different recommended flow schedules. If flow exceedance curves for the recommended flows are less than or equal to the flow exceedance curves for the LSJR alternatives, and if it is determined that the recommended flow schedule is more protective than the percent of unimpaired flow pursuant to the LSJR alternatives, then adequate water would generally be available to meet the recommended flows. Accordingly, this category of recommendation is effectively included within the LSJR alternatives analyzed in this SED. Moreover, there is no information to support a conclusion that a fixed monthly flow objective would reduce or avoid potentially significant effects on the environment any more than the current alternatives.

Contra Costa County Department of Conservation and Development

The Contra Costa County Department of Conservation and Development (CCCDCD) submitted scoping comments on the *Southern Delta Agriculture and San Joaquin River Flows Revised Notice of Preparation* (CCCDCD 2011). The CCCDCD scoping comments included recommendations on setting quantitative LSJR flow objectives that would have percentages of unimpaired flow that vary by month yet ensure additional reduced-flow impacts are not created outside of the February–June period. Presented in Table 3-2 are the flow schedule-based recommendations submitted by CCCDCD.

Table 3-2. Contra Costa County Department of Conservation and Development Flow Schedule-Based Recommendations

	Minimum Monthly Average Flow as a Percentage of Monthly Unimpaired Flow				
Month	Vernalis	Stanislaus River upstream of the confluence with the SJR	Tuolumne River upstream of the confluence with the SJR	Merced River upstream of the confluence with the SJR	Upper SJR upstream of the confluence with the Merced
Jan[a]	20	20 with an upper cap[b]	20 with an upper cap	20 with an upper cap	20 with an upper cap
Feb	50	30	30	30	30
Mar	50	30	30	30	30
Apr	40	20	20	20	20
May	30	20	20	20	20
Jun	30	20	20	20	20
Jul–Dec[a]	20	20 with an upper cap	20 with an upper cap	20 with an upper cap	20 with an upper cap

[a] Minimum flows are also needed outside the February–June period of greatest concern for fish and wildlife to ensure flow impacts are not redirected to the July–January period.

[b] The upper cap should be based on the 70th percentile of the unimpaired flows for each tributary and month. In other words, the minimum flow requirement of 20% of unimpaired flow would generally apply in critical, dry, and normal years but would be capped at 20% of the 70th-percentile unimpaired flow in wet years. This cap would only apply from July–January (i.e., outside of the period of greatest concern for fish).

Comparison of the exceedance plots for flow at Vernalis in Figure 3-2 indicates that LSJR Alternatives 2, 3, and 4 encompass the CCCDCD flow recommendations for all water year types. The CCCDCD flow recommendations are less than LSJR Alternative 4 in all years. The CCCDCD flow recommendations are generally greater than LSJR Alternative 2 in all years and would not avoid or substantially lessen potentially significant effects.

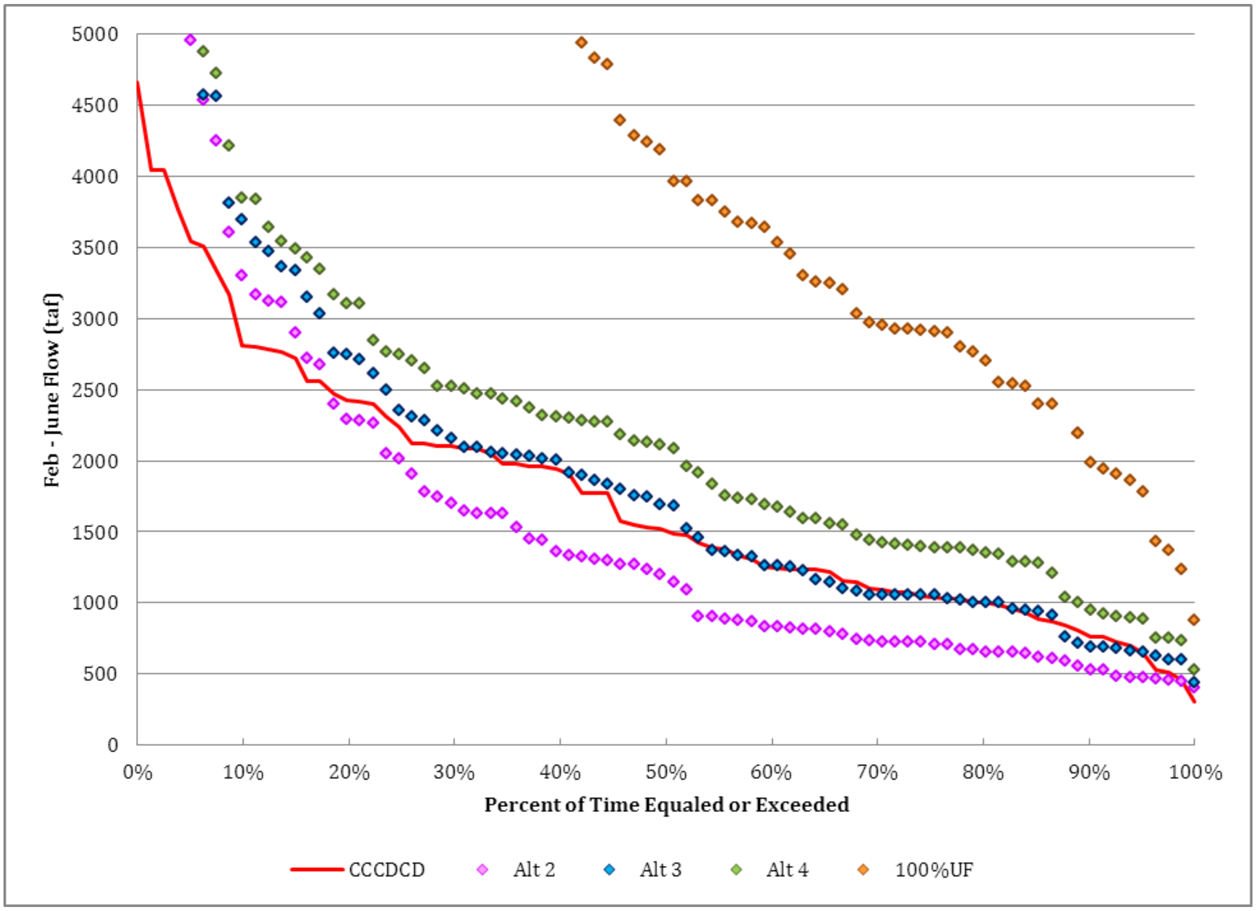

Figure 3-2. Flow Exceedance Plot of Contra Costa County Department of Conservation and Development's (CCCDCD's) Flow Recommendations and State Water Board's LSJR Alternatives (TAF = thousand acre-feet; UF = unimpaired flow)

California Department of Fish and Wildlife

CDFW (formerly the California Department of Fish and Game) provided written testimony and closing comments as part of the State Water Board Proceeding to Develop Flow Criteria for the Delta (CDFG 2010a, 2010b). CDFG testimony and comments included flow recommendations for the SJR at Vernalis that would double Chipps Island SJR fall-run Chinook salmon smolt production from 78,210 to more than 156,420 (derived from SJR Salmon Model V.1.6 output). Table 3-3 presents the flow schedule-based recommendations from CDFG.

Table 3-3. California Department of Fish and Game Flow Schedule-Based Recommendations, 2010 (cubic feet per second)

Water Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
C				1500 (Base) 5500 (Pulse) (4/15-5/15) (Total 7000)								
D				2125 (Base) 4875 (Pulse) (4/11-5/20) (Total 7000)								
BN				2258 (Base) 6242 (Pulse) (4/6-5/25) (Total 8500)								
AN				4339 (Base) 5661 (Pulse) (4/1-5/30) (Total 10000)								
W				6315 (Base) 8685 (Pulse) (3/27-6/4) (Total 15000)								

C = critical
D = dry
BN = below normal
AN = above normal
W = wet

A comparison of the exceedance plots for flow at Vernalis in Figure 3-3 indicates that LSJR Alternatives 2, 3, and 4 generally encompass the CDFG flow recommendations. The CDFG flow recommendations are generally greater than LSJR Alternative 2 in all years, and would not avoid or substantially lessen potentially significant effects.

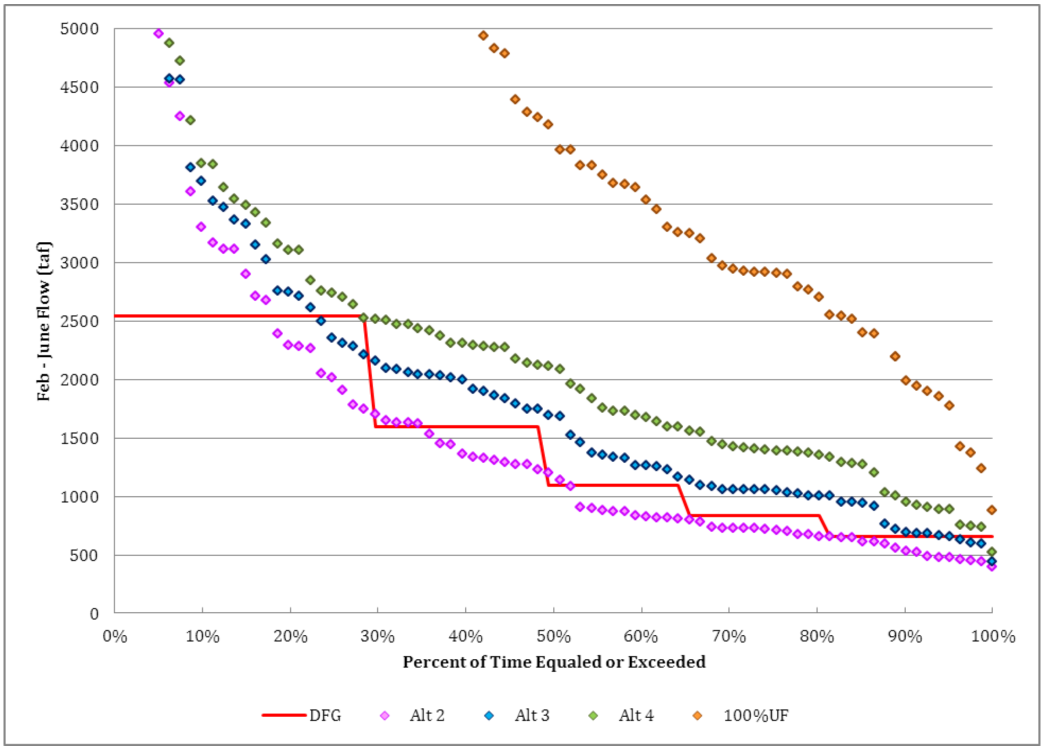

Figure 3-3. Flow Exceedance Plot of California Department of Fish and Game's (CDFG's) Flow Recommendations and State Water Board's LSJR Alternatives (TAF = thousand acre-feet; UF = unimpaired flow)

California Water Impact Network and California Sportfishing Protection Alliance

California Water Impact Network and California Sportfishing Protection Alliance (C-WIN/CSPA) provided closing comments as part of the State Water Board Proceeding to Develop Flow Criteria for the Delta (C-WIN 2010; CSPA 2010). The C-WIN/CSPA comments included flow recommendations based on pulse flows considered to match and facilitate the early life stages of salmonid larvae, juvenile rearing, and smoltification. Table 3-4 presents the flow schedule-based recommendations by C-WIN/CSPA.

Table 3-4. California Water Impact Network and California Sportfishing Protection Alliance Flow Schedule-Based Recommendations (cubic feet per second)

<table>
<tr><th>Water Year</th><th colspan="2">Jan</th><th colspan="2">Feb</th><th colspan="2">Mar</th><th colspan="2">Apr</th><th colspan="2">May</th><th colspan="2">Jun</th><th colspan="2">Jul</th><th colspan="2">Aug</th><th colspan="2">Sept</th><th colspan="2">Oct</th><th colspan="2">Nov</th><th colspan="2">Dec</th></tr>
<tr><td>C</td><td colspan="3"></td><td colspan="2">13400</td><td>4500</td><td>6700</td><td>8900</td><td colspan="3">1200</td><td colspan="8"></td><td>5400</td><td colspan="4"></td></tr>
<tr><td>D</td><td colspan="3"></td><td colspan="2">13400 (2 days)</td><td>4500</td><td>6700</td><td>8900</td><td colspan="3">1200</td><td colspan="8"></td><td>5400</td><td colspan="4"></td></tr>
<tr><td>BN</td><td colspan="3"></td><td colspan="2">13400 (16 days), 26800 (2 days)</td><td>4500</td><td>6700</td><td>8900</td><td>11200</td><td colspan="2">1200</td><td colspan="8"></td><td>5400</td><td colspan="4"></td></tr>
<tr><td>AN</td><td colspan="3"></td><td colspan="2">13400 (13 days), 26800 (5 days)</td><td>4500</td><td>6700</td><td>8900</td><td>11200</td><td colspan="2">1200</td><td colspan="8"></td><td>5400</td><td colspan="4"></td></tr>
<tr><td>W</td><td colspan="3"></td><td colspan="2">13400 (17 days), 26800 (5 days)</td><td colspan="4">13400</td><td colspan="2">14900</td><td colspan="8"></td><td>5400</td><td colspan="4"></td></tr>
</table>

Note: Critically dry is 13,400 for 2 days.

C = critical
D = dry
BN = below normal
AN = above normal
W = wet

Comparison of the exceedance plots for flow at Vernalis in Figure 3-4 indicates that LSJR Alternatives 2, 3, and 4 largely encompass the C-WIN/CSPA flow recommendations and entirely encompasses them for above-normal and dry water year types. The C-WIN/CSPA flow recommendations are generally greater than LSJR Alternative 2 in all years, and would not avoid or substantially lessen potentially significant effects.

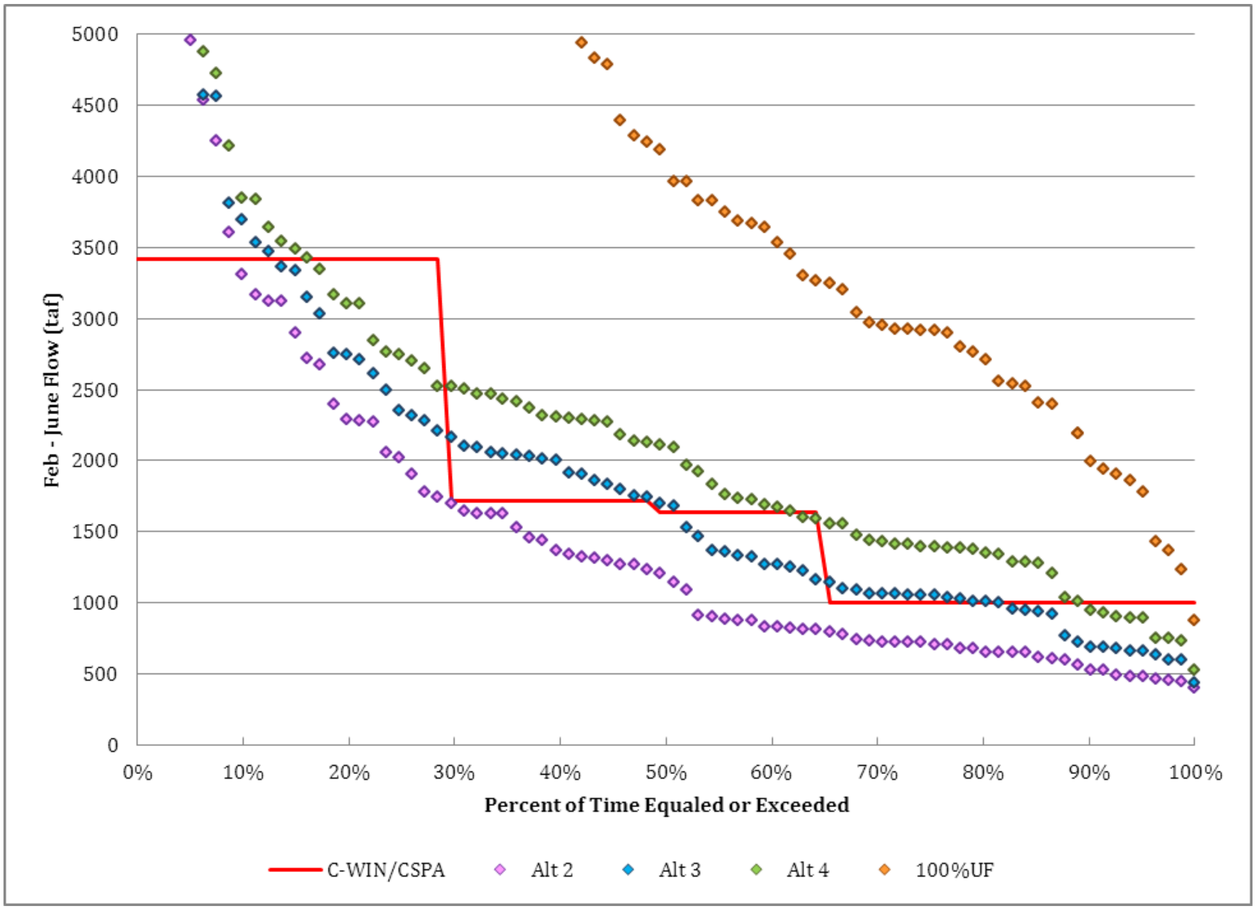

Figure 3-4. Flow Exceedance Plot of California Water Impact Network and California Sportfishing Protection Alliance's (C-WIN/CSPA) Flow Recommendations and State Water Board's LSJR Alternatives (TAF = thousand acre-feet; UF = unimpaired flow)

The Bay Institute and Natural Resources Defense Council

The Bay Institute and Natural Resources Defense Council (TBI/NRDC) provided testimony and closing comments as part of the State Water Board Proceeding to Develop Flow Criteria for the Delta (TBI/NRDC 2010a, 2010b, 2010c). The TBI/NRDC testimony and comments included flow recommendations developed by analyzing the relationship between LSJR flows with abundance, productivity, and life history diversity of SJR fall-run Chinook salmon. Table 3-5 presents the TBI/NRDC flow schedule-based recommendations.

Table 3-5. The Bay Institute and Natural Defense Council Flow Schedule-Based Recommendations (cubic feet per second)

<table>
<tr><th>Water Year</th><th colspan="2">Jan</th><th colspan="2">Feb</th><th colspan="2">Mar</th><th colspan="2">Apr</th><th colspan="2">May</th><th colspan="2">Jun</th><th colspan="2">Jul</th><th colspan="2">Aug</th><th colspan="2">Sept</th><th colspan="2">Oct</th><th colspan="2">Nov</th><th colspan="2">Dec</th></tr>
<tr><td>100% of years (all yrs)</td><td colspan="6">2000</td><td colspan="4">5000</td><td colspan="14">2000</td></tr>
<tr><td>80% (D yrs)</td><td colspan="6">2000</td><td>5000</td><td>10000</td><td>7000</td><td>5000</td><td colspan="14">2000</td></tr>
<tr><td>60% (BN yrs)</td><td colspan="6">2000</td><td>20000</td><td>10000</td><td>7000</td><td>5000</td><td colspan="14">2000</td></tr>
<tr><td>40% (AN yrs)</td><td colspan="5">2000</td><td>5000</td><td colspan="2">20000</td><td colspan="2">7000</td><td colspan="14">2000</td></tr>
<tr><td>20% (W yrs)</td><td colspan="5">2000</td><td>5000</td><td colspan="3">20000</td><td colspan="2">7000</td><td colspan="13">2000</td></tr>
</table>

D = dry
BN = below normal
AN = above normal
W = wet

Comparison of the exceedance curves shown in Figure 3-5 indicates that the State Water Board's flow resulting at Vernalis from the range of LSJR alternatives generally encompasses the TBI/NRDC flow recommendations and entirely encompasses them for above-normal and dry water year types. The TBI/NRDC flow recommendations are generally greater than LSJR Alternative 2 in all years, and would not avoid or substantially lessen potentially significant effects.

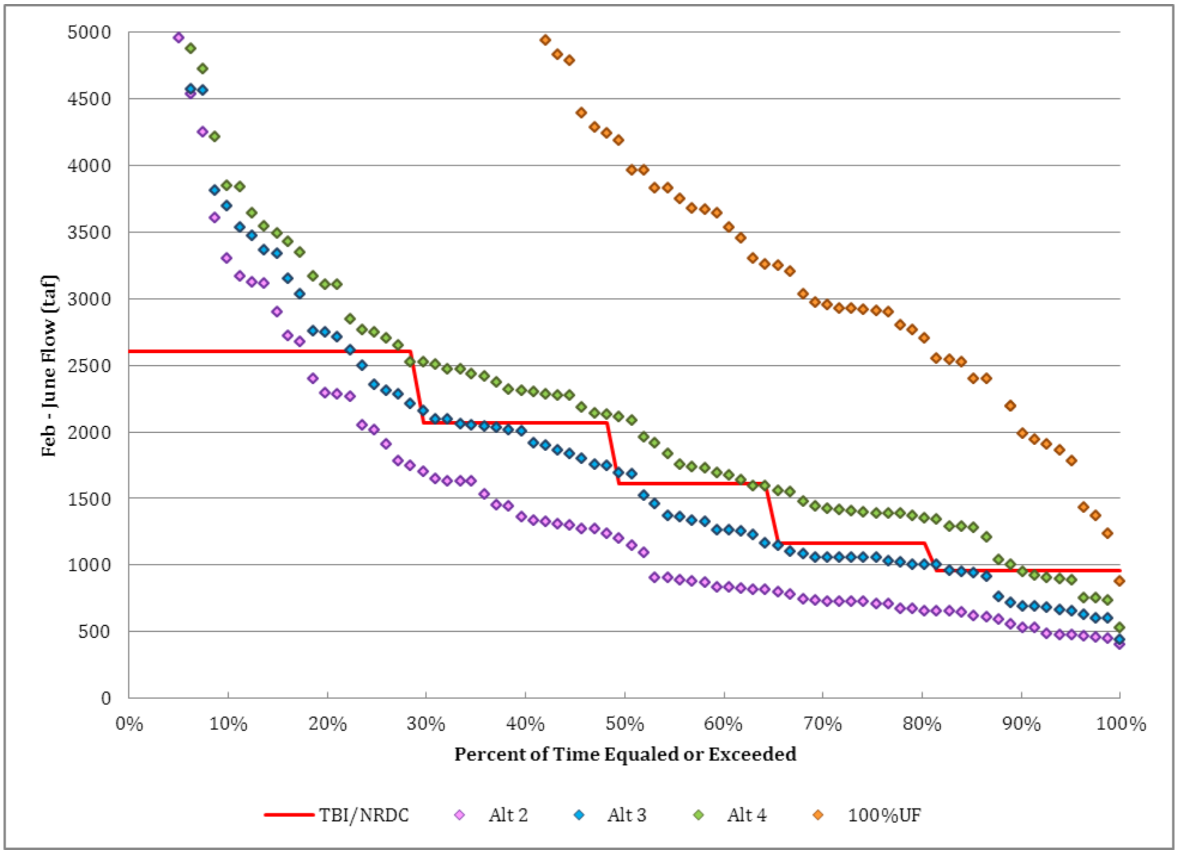

Figure 3-5. Flow Exceedance Plot of The Bay Institute and Natural Defense Council's (TBI/NRDC) Flow Recommendations and State Water Board's LSJR Alternatives (TAF = thousand acre-feet; UF = unimpaired flow)

American Rivers and Natural Heritage Institute

The American Rivers and Natural Heritage Institute (AR/NHI) provided testimony and closing comments as part of the State Water Board Proceeding to Develop Flow Criteria for the Delta (AR/NHI 2010a, 2010b). Included in the testimony and closing comments were recommendations for LSJR flows that would benefit salmon rearing habitat and smolt outmigration (i.e., increased flow velocities and turbidity), with focus on temperature (i.e., maintaining temperature at or below 65°F). These flow recommendations are to be in addition to those stipulated in D-1641. Table 3-6 presents the flow schedule-based recommendations provided in the AR/NHI testimony and closing comments.

Table 3-6. American Rivers and Natural Heritage Institute Flow Schedule-Based Recommendations

<table>
<tr><th>Water Year</th><th>Jan</th><th>Feb</th><th colspan="2">Mar</th><th colspan="2">Apr</th><th colspan="2">May</th><th colspan="2">Jun</th><th>Jul</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>100% of years (all yrs)</td><td></td><td></td><td>3000</td><td>4000</td><td colspan="3">5000</td><td colspan="3">2000</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>80% (D yrs)</td><td></td><td></td><td>3000</td><td>4000</td><td>5000</td><td>10000</td><td>7000</td><td>5000</td><td colspan="2">2000</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>60% (BN yrs)</td><td></td><td></td><td>3000</td><td>5000</td><td>20000</td><td>10000</td><td>7000</td><td>5000</td><td colspan="2">2000</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>40% (AN yrs)</td><td></td><td></td><td>3000</td><td>5000</td><td colspan="2">20000</td><td colspan="2">7000</td><td colspan="2">2000</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>20% (W yrs)</td><td></td><td></td><td>3000</td><td>5000</td><td colspan="3">20000</td><td colspan="2">7000</td><td>2000</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>All</td><td></td><td></td><td colspan="6">Flows of approx. 10000 cfs should occur at Vernalis for ≥5 days. There should be at least 2 such events in dry years, and more in wetter years.</td><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

D = dry
BN= below normal
AN= above normal
W = wet

Comparison of the exceedance plots for flow at Vernalis in Figure 3-6 indicates that LSJR Alternatives 2, 3, and 4 generally encompass the AR/NHI flow recommendations and entirely encompass them for above-normal and dry water year types. The AR/NHI flow recommendations are generally greater than LSJR Alternative 2 in all years, and would not avoid or substantially lessen potentially significant effects.

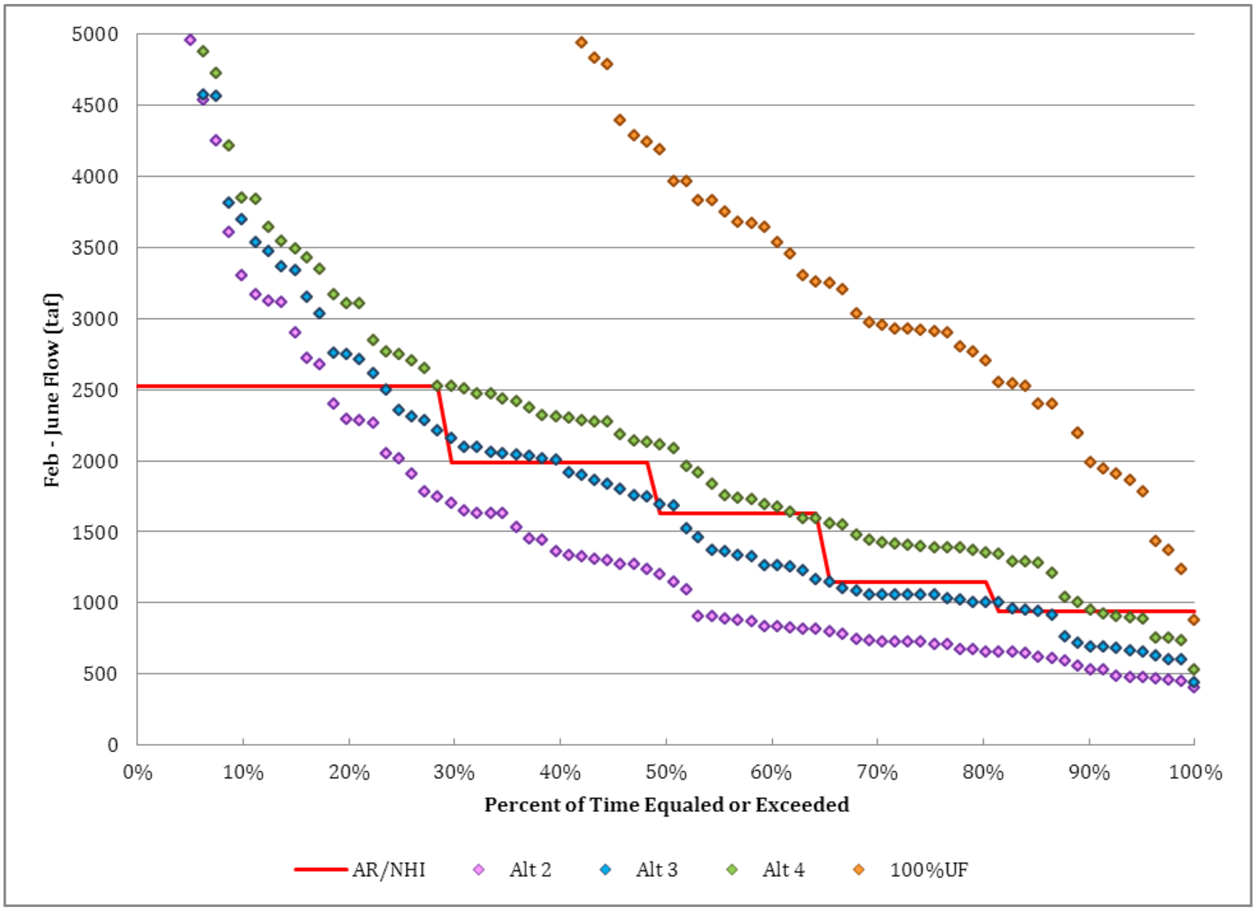

Figure 3-6. Flow Exceedance Plot of American Rivers and Natural Heritage Institute's (AR/NHI) Flow Recommendations and State Water Board's LSJR Alternatives (TAF = thousand acre-feet; UF = unimpaired flow)

U.S. Department of the Interior

Pursuant to the Central Valley Project Improvement Act (CVPIA), the U.S. Department of the Interior (DOI) is required to develop and implement measures to at least double the natural production of anadromous fish in Central Valley streams; the program to achieve this is known as the Anadromous Fish Restoration Program (AFRP). DOI submitted a written summary and witness testimony on behalf of both USFWS and USBR as part of the State Water Board Proceeding to Develop Flow Criteria for the Delta (DOI 2010). DOI recommended evaluation of the flow recommendations contained within the CVPIA's 2005 AFRP Report (USFWS 2005) for salmon population doubling and increasing salmon population by 53 percent. Table 3-7 presents USFWS/USBR flow recommendations, as stated in the CVPIA's 2005 AFRP Report, for salmon population doubling and increasing salmon population by 53 percent.

Table 3-7. Central Valley Project Improvement Act's 2005 Anadromous Fish Restoration Program Report Flow Schedule-Based Recommendations (cubic feet per second)

	Water Year Type	Flow			
		Feb	Mar	Apr	May
Doubling Salmon Population	C	1744	2832	4912	5665
	D	1784	3146	5883	7787
	BN	1809	3481	6721	9912
	AN	2581	5162	8151	13732
	W	4433	8866	10487	17369
53% Increase in Salmon Population	C	1250	1665	2888	3331
	D	1350	1850	3459	4579
	BN	1450	1933	3733	5505
	AN	1638	2703	4266	7194
	W	2333	4667	5520	9142

C = critical
D = dry
BN = below normal
AN = above normal
W = wet

Comparison of the exceedance plots for flow at Vernalis in Figure 3-7 indicates that LSJR Alternatives 2, 3, and 4 encompass the USFWS/USBR salmon population doubling flow recommendations for above-normal, below-normal, and dry water year types. The USFWS/USBR salmon population doubling flow recommendations are generally greater than LSJR Alternative 2 in all years.

Comparison of the exceedance plots for flow at Vernalis in Figure 3-7 indicates that LSJR Alternatives 2, 3, and 4 generally encompass the USFWS/USBR flows. With the exception of critical years, the LSJR alternatives entirely encompass both sets of flows. The USFWS/USBR salmon population 53 percent increase flow recommendations are generally lower than LSJR Alternative 2 in most years. These recommendations would not avoid or substantially lessen potentially significant effects, and in years with lower flows, would not meet the plan amendment purpose and goals of protecting the fish and wildlife beneficial uses, including by maintaining inflow conditions sufficient to support and maintain the natural production of viable migratory fish populations.

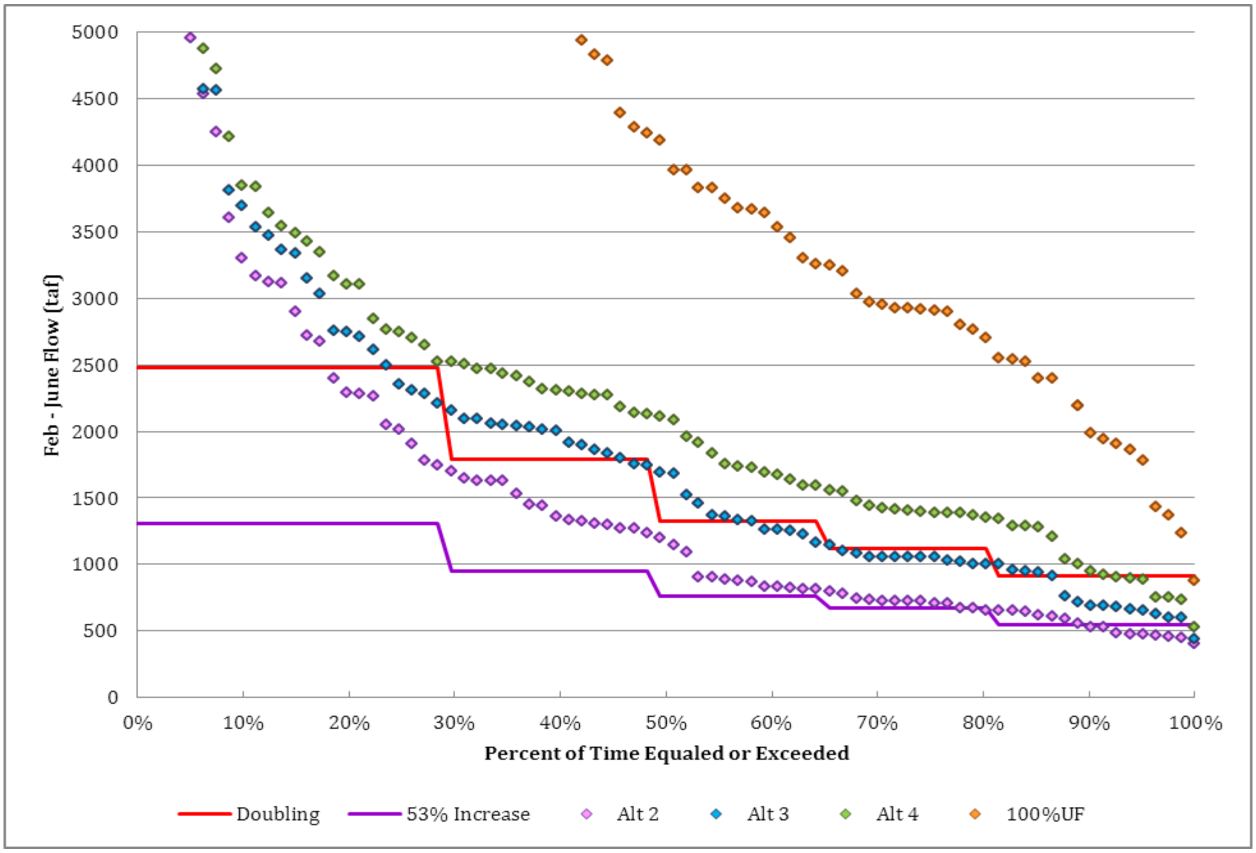

Figure 3-7. Flow Exceedance Plot of Central Valley Project Improvement Act's 2005 Anadromous Fish Restoration Program's Flow Recommendations and State Water Board's LSJR Alternatives (TAF = thousand acre-feet; UF = unimpaired flow)

Delta Solution Group

During the development of flow criteria for the Sacramento–San Joaquin Delta, the State Water Board invited a group of experts to participate in and provide scientific information relevant to the Delta Flow Criteria Informational Proceeding. This led to the formation of the Delta Environmental Flows Group. A subset of this group was the U.C. Davis Delta Solutions Group (DSG), who prepared three papers to inform the Delta Flow Criteria Informational Proceeding. Of the three papers, Fleenor et al. (2010) explored several approaches for establishing freshwater flow prescriptions. Detailed in the Fleenor et al. (2010) paper are functional flow prescriptions to support and promote habitat conditions for desirable estuarine fishes. In Table 3-8 are the LSJR flow schedule-based recommendations presented in the Fleenor et al. (2010) paper by the DSG.

Table 3-8. Delta Solution Group LSJR Flow Schedule-Based Recommendations (cubic feet per second)

Water Year Type	Flow											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
C	2000	2000	2000	5000	2000	2000	2000	2000	2000	2000	2000	2000
D	2000	2000	2000	7000[a]	2000[b]	2000	2000	2000	2000	2000	2000	2000
BN	2000	2000	2000	10000	2000	200	2000	2000	2000	2000	2000	2000
AN	2000	2000	2000	15000	15000[c]	2000[d]	2000	2000	2000	2000	2000	2000
W	2000	2000	2000	20000	20000	20000	2000	2000	2000	2000	2000	2000

C = critical
D = dry
BN = below normal
AN = above normal
W = wet

[a] 7000 cubic feet per second (cfs) from April 1–May 15.

[b] 2000 cfs from May 16–December 31.

[c] 15000 cfs from May 1–June 15th.

[d] 2000 cfs from June 16–December 31.

Comparison of the exceedance plots for flow at Vernalis in Figure 3-8 indicates that LSJR Alternatives 2, 3, and 4 generally encompass the DSG flow recommendations with the exception of wetter years when flows are often uncontrolled and may incidentally meet the proposed levels. The DSG flow recommendations are generally greater than LSJR Alternative 2 in all years and would not avoid or substantially lessen potentially significant effects.

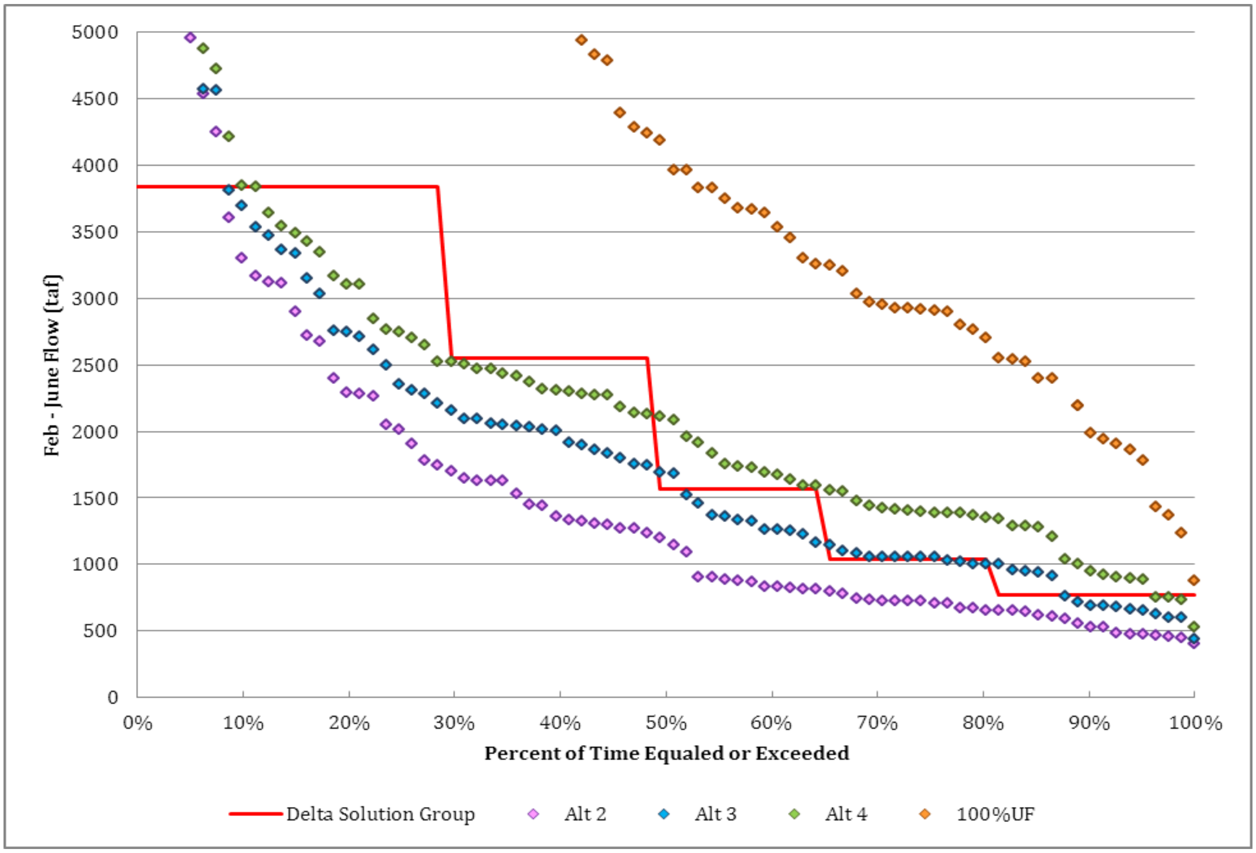

Figure 3-8. Flow Exceedance Plot of Delta Solution Group's Flow Recommendations and State Water Board's LSJR Alternatives (TAF = thousand acre-feet; UF = unimpaired flow)

The LSJR alternatives considerably bracket the flow schedule-based recommendations submitted by commenters. There are, however, periods of time when the flow recommendations are outside of this bracket, and the LSJR alternatives provide more or less flow than the recommendations. Table 3-9 presents the number of years out of 82 that the February–June flow schedule-based recommendations exceed LSJR Alternative 4 flows.

Table 3-9. Number of Years February– June Flow Schedule-Based Recommendations Exceed LSJR Alternative 4 at Vernalis by Water Year Type

Water Year Type	Total Number of Years (1922–2003) per Water Year Type	Recommendation							
							USFWS/USBR		
		CCCDCD	CDFG	C-WIN/CSPA	TBI/NRDC	AR/NHI	Doubling	53% Incr.	DSG
W	24	0	4	10	4	4	4	0	15
AN	16	0	0	0	0	0	0	0	13
BN	13	0	0	2	2	2	0	0	1
D	13	0	0	0	0	0	0	0	0
C	16	0	1	9	9	8	7	1	4
Total	82	0	5	21	15	14	11	1	33

USFWS = U.S. Fish and Wildlife Service
USBR = U.S. Bureau of Reclamation
CCCDCD = Contra Costa County Department of Conservation and Development
CDFG = Department of Fish and Game
C-WIN/CSPA = California Water Impact Network and California Sportfishing Protection Alliance
TBI/NRDC = The Bay Institute and Natural Resources Defense Council
AR/NHI = The American Rivers and Natural Heritage Institute
DSG = Delta Solutions Group
W = wet
AN = above normal
BN = below normal
D = dry
C = critical

With the exception of the C-WIN/CSPA and DSG, LSJR Alternative 4 provides more flow than the recommendations for 80–100 percent of the 24 wet water years evaluated. For critically-dry years, LSJR Alternative 4 provides more flow than CCCDCD (all critically-dry years), CDFG/USBR 53 percent salmon increase recommendations (15 out of 16 critically-dry years), and DSG (12 out of 16 years), but less flow than C-WIN/CSPA, TBI/NRDC, AR/NHI, and USBR Doubling recommendations in 9, 9, 8, and 7 years out of 16 critically-dry years, respectively.

For the time periods when the aforementioned flow recommendations are within the LSJR alternatives' brackets, the LSJR alternatives exceed the recommendations. The result is a balance in which the time the LSJR alternatives are not satisfying the recommendations is offset by the time the alternatives exceed the recommendations. The LSJR alternatives may not satisfy each of the flow recommendations all the time, but the flow schedule-based recommendations are satisfied the majority of the time. Further, adaptive management of flows would increase the amount of time that the flow recommendations are achieved if information indicates that achieving these schedules is more protective of fish and wildlife. In general, these recommendations would not avoid or substantially lessen potentially significant effects. To the extent lower flows are proposed, they would not meet the plan amendment purpose and goals of protecting the fish and wildlife beneficial uses, To the extent that higher flows are proposed, they would not meet the plan amendment purpose and goal to consider all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries.

Other Suggested Program of Implementation Elements

Additional program of implementation suggestions for the LSJR flow objectives involve water rights. These suggestions are described below.

Commenters suggested that this SED should evaluate a "No Action Implementation Alternative," with a program of implementation under which the 2006 Bay-Delta Plan narrative objective for LSJR flows would not be amended, D-1641 would remain in place, and USBR would be responsible for meeting D-1641. The No Project Alternative evaluated in this SED consists of these elements.

One commenter suggested an "Upstream Inclusion Alternative" that was to include flow contributions and implementation measures from throughout the entire historical SJR Watershed, including flow contributions upstream of the Merced River. The purpose of the plan amendments is to establish flow objectives and a program of implementation for the LSJR, including the three eastside salmon-bearing tributaries. This flow proposal applies to the entire migration pathway of salmon from the rim dams on the three salmon bearing tributaries of the SJR to the SJR near Vernalis. Currently, the SJR does not support salmon runs upstream of the Merced River confluence (Upper SJR). However, pursuant to the San Joaquin River Restoration Program (SJRRP), spring-run Chinook salmon are planned to be reintroduced to the Upper SJR no later than December 31, 2012. Flows needed to support this reintroduction are being determined and provided through the SJRRP. During the next review of the Bay-Delta Plan, the State Water Board will consider information made available through the SJRRP process, and any other pertinent sources of information, in evaluating the need for any additional flows from the Upper SJR Basin to contribute to the narrative LSJR flow objective. At this time, however, an alternative that would require flow contributions upstream of the Merced River would not meet the plan amendment goals of providing more flows on the three east-side salmon-bearing tributaries, unless it were in addition to flows on the Merced, Tuolumne, and Stanislaus Rivers. Additional flows from upstream of the Merced would increase, rather than reduce or substantially lessen, potentially significant environmental effects.

A "South Delta and Lower San Joaquin Alternative" was a commenter suggestion that would restrict water diverters in the southern Delta and LSJR from diverting water that was released upstream to meet the narrative objective. The alternative would include a mechanism to assure flows released pursuant to the narrative objective are not rediverted downstream for purposes other than meeting the narrative objective. The program of implementation in Appendix K, *Revised Water Quality Control Plan*, addresses this alternative with the following language:

> "The State Water Board will exercise its water right and water quality authority to help ensure that the flows required to meet the LSJR flow objectives are used for their intended purpose and are not diverted for other purposes."

This alternative would not reduce or substantially lessen potentially significant environmental effects.

3.4 Southern Delta Water Quality (SDWQ) Alternatives

The development of alternatives requires an understanding of the attributes of alternatives that could feasibly attain most of the basic objectives of the plan amendments but would avoid or substantially lessen any of the significant environmental effects. Attributes of salinity objective alternatives may be described or constrained by geographic scope, season and averaging period, and the level of protection. These attributes of salinity objectives can then be used to assess the potential for alternatives to achieve plan amendment goals and to have potential effects, in order to determine which alternatives are feasible, and should be evaluated, and which are infeasible, and may eliminated from further consideration.

In evaluating potential amendments to the Bay-Delta Plan, the State Water Board identified the fundamental purpose of the plan amendments:

> "To establish southern Delta water quality objectives for the reasonable protection of southern Delta agricultural beneficial uses and a program of implementation to achieve the objectives."

As discussed in Section 3.2, *Purposes and Goals*, the purpose of the plan amendments is to establish southern Delta water quality objectives for the reasonable protection of southern Delta agricultural beneficial uses. Salinity levels in the southern Delta are affected primarily by the salinity of water flowing into the southern Delta from the SJR near Vernalis and the evapoconcentration of salts in water diverted and discharged back into the channels. Point sources of salt in the southern Delta have a small overall salinity effect (Appendix C, *Technical Report on the Scientific Basis for Alternatives*, and Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*). Accordingly, the State Water Board identified a numeric range of alternatives that would be met through flow as the means of protecting agricultural beneficial uses. Additional information related to southern Delta salinity is provided in Appendix C.

3.4.1 Attributes of the SDWQ Objectives

Attributes of salinity alternatives that inform the feasibility of alternatives and the ability of alternatives to avoid or substantially lessen any of the significant effects of the project are: magnitude/level of protection, seasonality and averaging period, geographic scope, and other measure, such as improved circulation.

Magnitude/Level of Protection

The magnitude of salinity alternatives could vary over a wide range because different crops have a wide range of sensitivities to salinity. Salt sensitivity is affected by a number of variables including soil characteristics, irrigation and management techniques, and rainfall. Salt sensitive crops of significance in the southern Delta include almond, apricot, dry bean, and walnut, with dry bean being the most sensitive. Analyses and modeling summarized in Appendix C, *Technical Report on the Scientific Basis for Alternatives*, show that water quality objectives could be 0.9–1.1 deciSiemens per meter (dS/m) and be protective of all crops normally grown in the southern Delta under current irrigation practices, although during low rainfall years, this might lead to yield loss of approximately 5 percent under certain conditions. Additional information summarized in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento-San Joaquin Delta*, shows that crops such as alfalfa, although somewhat more salt tolerant, is frequently grown on low permeability soils with low leaching fractions. The report shows that alfalfa grown on low permeability soils (with a very low leaching fraction of 0.10) with irrigation water of 1.4 dS/m might lead to yield loss of approximately 5 percent under certain conditions (Appendix E, Figure 5.13).

Revision of other salinity objectives in the Bay-Delta Plan are not being considered at this time, including the salinity objectives for the protection of agricultural beneficial uses at the intakes of the Central Valley Project (Delta Mendota Canal at Tracy Pumping Plant) and State Water Project (West

Canal at Clifton Court Forebay). The objectives at these locations, which are west, and generally downstream of, the southern Delta salinity stations, are 1.0 dS/m on a monthly average, year-round. The federal Central Valley Project (CVP) and State Water Project (SWP) both also deliver water to cities for drinking water supply.

Drinking water has a Recommended Secondary MCL of 0.9 dS/m, with an Upper MCL of 1.6 dS/m and a Short Term MCL of 2.2 dS/m. Salinities lower than the Secondary MCL are more desirable to a higher degree of consumers, however, it can be exceeded and is deemed acceptable to approach the Upper MCL if it is neither reasonable nor feasible to provide more suitable waters.

For these reasons, water salinity of 1.4 dS/m was selected as the upper limit for SDWQ alternatives, even though this level is higher than other objectives in the immediate area and above the Recommended Secondary MCL. Salinity of 1.4 dS/m is the level at which crops in the southern Delta would have no more than a 5 percent yield loss, and still complies with the 1.6 dS/m drinking water Upper MCl.

This limit achieves goals 1 and 3.

1. Provide salinity conditions that reasonably protect agricultural beneficial uses of surface waters in the southern Delta."

3. Establish a salinity objective, supported by existing scientific information, that is not lower than necessary to reasonably protect the most salt sensitive crops currently grown or suitable to be grown on saline- and drainage-impaired soils in the southern Delta.

Salinity levels in the southern Delta are now maintained at levels generally no higher than approximately 1.0 dS/m because USBR is required, under terms of its water rights, to maintain EC levels of 0.7 dS/m at Vernalis for April– August and 1.0 dS/m for September–March, as a maximum 30-day running average. Salinity generally increases downstream of Vernalis, in the southern Delta, principally as a result of evapoconcentration of salt when the water is used and returned, in smaller quanities, by agriculture in the southern Delta. This evapoconcentation of salts is greatest during peak periods of irrigation and consumptive use of water, which corresponds to the April–August time period. The USBR maintains salinity at Vernalis through the release of low salinity water from New Melones Reservoir. Currently this requires the release of approximately 3 TAF per year (TAF/y) on average to meet the Vernalis salinity requirement. Although there are number of projects that have been developed and are currently under development to reduce salt loading in the SJR, release of stored water by USBR will continue to be the principal means to comply with the salinity objective at Vernalis.

Lowering the objective below the current seasonal requirements of 0.7 and 1.0 dS/m at Vernalis would require the release of even more water for the sole purpose of meeting the lower objective. This means that salinity objectives lower than 0.7 and 1.0 dS/m in the interior southern Delta locations could not be achieved without the release of stored water because salinity generally increases in the southern Delta downstream from Vernalis. Objectives lower than 1.0 were eliminated from consideration because if such low salinities were required in the interior southern Delta this would require much lower salinity at Vernalis to account for the degradation of water quality that occurs downstream, and thus the release of more stored water. Modeling of the No Project Alternative, which includes full compliance with current interior southern Delta salinity objectives, shows that approximately 60 TAF/y, on average, would have to be released from New Melones Reservoir to meet the 0.7 dS/m April–August and 1.0 ds/cm September–March objectives in the interior southern Delta (see Table D.3 in Appendix D, *Evaluation of No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)* for estimated New Melones water quality releases for baseline and the No Project Alternative). Water released from storage would not be available for other uses of water. Salinity objectives lower than 0.7 dS/m at Vernalis were eliminated from consideration because of the unreasonably high water costs.

In addition to achieving goals 1 and 3, evaluation of a southern Delta salinity objective no lower than 1.0 dS/m also achieves goals 2 and 4.

2. In establishing salinity water quality objectives to reasonably protect agricultural beneficial uses, take into consideration all of the demands being made and to be made on waters in the southern Delta, the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.
4. Maintain or improve salinity conditions in the southern Delta to comply with state and federal antidegradation policies.

Seasonality and Averaging Period

Steady-state modeling presented in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento-San Joaquin Delta*, and the results from other transient model studies suggest that the water quality objective could be increased up to 0.9 to 1.1 dS/m and be protective of all crops normally grown in the southern Delta under current irrigation practices. These models calculate the effect of irrigation water quality on soil water salinity, but it is soil water salinity that ultimately affects crop yield, not the salinity of the irrigation water itself. That is why it is possible, in general, to irrigate with higher salinity water on high permeability soils. With the adequate leaching provided by high permeability soils, salts are flushed from the root zone, thus keeping soil water salinities relatively low. The steady state and transient state modeling analysis all assume constant salinity, rather than variable mean annual or variable mean seasonal salinity. The models do, however, consider the effects of additional leaching of salts from the soil profile that occurs as a result of precipitation. Precipitation, unlike most irrigation water, contains no added salt, so has the effect of leaching salts from the soil.

This means that long averaging periods, longer than a 30-day average, have the potential to cause more significant local and seasonal negative effects. Short duration high salinity water supply has the potential to coincide with irrigation of crops, and could therefore have large negative effects because the irrigated crop does not "see" the average salinity. This is particularly the case if high salinity water coincides with irrigation of a salt sensitive crop during emergence and early seedling development, when crops can be most susceptible to damage from high salinity.

Shorter duration averaging periods were deemed infeasible because a short duration average would effectively lower the required salinity objective by reducing the ability to even out high and low salinities. As discussed under magnitude/level of protection above, this would have unreasonable water costs.

Geographic Scope

Different objectives could be considered at different locations to account for different soil types, circulation patterns in back channels of the Delta, and the ability to achieve certain threshold salinity. Variability in soils, including the variable leaching requirement of soils in the southern delta are discussed in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento-San Joaquin Delta.* The irrigation water salinity requirements can vary depending on these and other such characteristics. Although more site-specific irrigation requirements, could be developed based on more detailed soil surveys and models, Appendix E has already taken into account the variability, and the most limiting characteristics of soils and crops grown in the southern delta, to determine, a range in irrigation water salinity that would result in no more than a 5 percent yield reduction for the most sensitive crops. This also means that most crops would not suffer yield reductions at all. Site specific salinity requirements would allow the salinity objective to be higher in some areas, but implementing such a set of variable objectives would be infeasible because of the mixed nature of the water supply.

Different salinity objectives could also be considered based on circulation patterns. Back water areas in the southern Delta, with poor circulation, are currently susceptible to locally higher salinity levels. As for varying soils, implementing a set of variable objectives would be infeasible to account for backwater areas because of the mixed nature of the water supply.

Finally, different salinity objectives could be considered to account for the need to provide assimilative capacity for downstream locations. This would be feasible for the Vernalis location because it is upstream of the interior southern Delta. Although feasible, a different objective in close proximity to other similar locations with the same beneficial use may suggest a different level of protection for the same use, which is not the case. As described below, the SDWQ alternatives rely upon the program of implementation to provide geographic variability by including an implementation provision for the needed assimilative capacity, instead of a different objective. As stated above, a salinity objective at Vernalis lower than 0.7 dS/m is infeasible. An implementation provision lower than 0.7 dS/m would therefore also be infeasible, and was not considered.

Other Measures

Measures other than salinity objectives could be employed to protect agricultural beneficial use. Such measures include improved (raised) water levels and improved flow patterns (circulation) that would have the effect of improving salinity conditions by evening out areas of high and low salinity and moving salts discharged into the southern Delta out of the area. Such measures could be used instead of, or in addition to, salinity objectives. There is a risk, however, that use of such measures without any numeric salinity objective may not protect agricultural beneficial uses. Improved circulation of high salinity water may help to move salts, but the agricultural use would still not be protected if background salinity is still high. Other measures are, therefore, most useful if combined with numeric objectives, unless specific physical measures can be identified and fully relied upon to protect the use.

3.4.2 SDWQ Alternatives Considered

This SED evaluates SDWQ Alternative 1 (No Project Alternative) and two other SDWQ alternatives (SDWQ Alternatives 2 and 3). SDWQ Alternatives 2 and 3 are comprised of a numeric objective and an associated program of implementation. SDWQ Alternatives 2 and 3 have different numeric objectives, which are described in detail below, and the same program of implementation. The different numeric objectives provide a basis for analyzing a range of alternatives that are not lower than necessary to reasonably protect the agricultural beneficial uses. The range of alternatives analyzed in this SED is based on the water quality needs of the most salt-sensitive crops grown in the southern Delta, the predominant soil type, and irrigation practices in the area. The range of alternatives analyzed help to inform which alternatives meet the purposes and goals of the plan amendments as discussed in Section 3.2, *Purposes and Goals*, while minimizing any potentially significant effects.

Appendix K, *Revised Water Quality Control Plan*, contains the proposed program of implementation for the southern Delta salinity objective. The program of implementation for SDWQ Alternatives 2 and 3 would require the USBR to continue complying with the terms of its water rights that require implementation of EC[8] levels of 0.7 dS/m at Vernalis for April–August and 1.0 dS/m for September–March as a maximum 30-day running average. This is in order to provide assimilative capacity so that the year-round salinity objective 1.0 dS/m can be met in the interior southern Delta after the consumptive use of water and evapoconcentration of salts that occur as a result of agricultural activities in the southern Delta downstream of Vernalis.

DWR and USBR are currently required, as a condition of their water rights, to meet EC levels of 0.7 dS/m from April–August and 1.0 dS/m from September–March at the three compliance stations in the interior southern Delta (Interagency Stations Nos. C-6, C-8, and P-12). As part of implementing the salinity objective for the interior southern Delta, DWR and USBR would be required to instead comply with the 1.0 dS/m objective year-round as a condition of their water rights.

DWR and USBR would also be required to develop a comprehensive operations plan to address the impacts of CVP and SWP export operations on interior southern Delta salinity levels. The operations plan must include detailed information, including describing actions that will address the impacts of SWP and CVP export operations on water levels and flow conditions that may affect salinity conditions in the southern Delta, containing information about the configuration and operations of any facilities relied upon in the plan, and identifying specific performance goals for the facilities.

USBR and DWR's water rights would also be conditioned to require continued operations of the agricultural barriers at specified locations, or other reasonable measures, to address the impacts their export operations. In addition, the program of implementation requires DWR and USBR to develop a long-term Monitoring and Reporting Plan to implement and determine compliance with the salinity objective and to inform the comprehensive operations plan. The agencies will be required to perform monitoring, modeling, special studies, and reporting activities, in coordination with other study and monitoring programs.

The program of implementation also includes recommendations to other agencies that would assist in meeting the SDWQ objective. SDWQ Alternatives 1, 2, and 3 are detailed below. As discussed earlier in this chapter, SDWQ Alternatives 2 and 3 have different numeric objectives but the same programs of implementation.

3.4.3 SDWQ Alternative 1: No Project Alternative

As discussed above in Section 3.3.4, *LSJR Alternative 1: No Project Alternative*, State CEQA Guidelines Section 15126.6, Subdivision (e) requires the evaluation of a no project alternative. When a project is the amendment of a regulatory plan, such as the 2006 Bay-Delta Plan, the no project alternative

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[8] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are, therefore, used interchangeably in this chapter.

will be the continuation of the existing plan into the future. In evaluating the impacts of a no project alternative, a lead agency should consider what is reasonably expected to occur in the foreseeable future. SDWQ Alternative 1 (No Project Alternative) assumes full compliance with the water quality objectives in the 2006 Bay-Delta Plan. In addition, the No Project analysis includes flows required by other entities such as the NMFS 2009 BO flow requirements on the Stanislaus River, FERC requirements on the Tuolumne and Merced Rivers, and the Davis Grunsky requirements on the Merced River. SDWQ Alternative 1 is the continuation of the existing water quality objectives for agricultural beneficial uses for the southern Delta contained in the 2006 Bay-Delta Plan as currently implemented by DWR and USBR. The 2006 Bay-Delta Plan states that the maximum 30-day running average of mean daily EC is 0.7 millimhos per centimeter (mmhos/cm)[9] April 1–August 30 and 1.0 mmhos/cm September 1–March 31 for all water year types. This is applicable to the three interior compliance stations (C-6, C-8, and P-12) and the compliance station at Vernalis (C-10). Under baseline, these salinity levels are not always fully met.

Chapter 15, *LSJR No Project Alternative (Alternative 1 and SDWQ Alternative 1),* and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, evaluate the potential impacts of the No Project Alternative. As described in Section 3.3.4, *LSJR Alternative 1: No Project Alternative*, LSJR Alternative 1 and SDWQ Alternative 1 are evaluated together as the No Project Alternative in Chapter 15 and Appendix D because continuation of the 2006 Bay-Delta Plan would require compliance with the Vernalis flow objectives and southern Delta salinity objective. Further, the proposed plan amendments consist of the revised flow and salinity water quality objectives and the LSJR flows are necessary to help achieve the salinity water quality objectives.

3.4.4 SDWQ Alternative 2

SDWQ Alternative 2 would establish a numeric salinity objective of 1.0 dS/m as a maximum 30-day running average of mean daily EC for all months in the SJR between Vernalis and Brandt Bridge, Middle River from Old River to Victoria Canal, and Old River/Grant Line Canal from the Head of Old River to West Canal.

3.4.5 SDWQ Alternative 3

SDWQ Alternative 3 is the same as SDWQ Alternative 2 except the maximum 30-day running average of mean daily EC is 1.4 dS/m for all months. The compliance locations are the same as for SDWQ Alternative 2. The program of implementation for SDWQ Alternatives 2 and 3 is the same. This alternative would lessen the impact on service providers because they would be able to reduce the level of treatment needed to comply with salinity requirements. This would, however, result in slightly higher salinity in some southern Delta channels, which would result in slightly lower yields of salt-sensitive crops.

3.4.6 SDWQ Alternatives Considered but Eliminated from Further Evaluation

The State Water Board is considering modifications to existing SDWQ salinity objectives to protect agricultural beneficial uses in the southern Delta. The range of alternatives examined in this SED

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[9] In this SED, electrical conductivity (EC) is generally expressed in deciSiemens per meter (dS/m). The conversion is 1 mmhos/cm = 1 dS/cm).

considers the information and overall conclusions provided in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*, and public comments.

In developing the SDWQ alternatives, the State Water Board considered public comments regarding alternatives to the southern Delta salinity objective and its implementation. Several comment letters suggested the State Water Board analyze salinity objectives within the range of the State Water Board's SDWQ alternatives, and the Board did not analyze those specific recommendations separately because they were already considered in the range of alternative analyzed. There were a few commenters who suggested the State Water Board analyze salinity objectives below 0.7 dS/m, which does not meet the plan amendment goal of establishing a salinity objective that is not lower than necessary to reasonably protect the most salt sensitive crops currently grown or suitable to be grown on saline-and drainage-impaired soils in the southern Delta. It also would not lessen environmental impacts. Other commenters suggested that the State Water Board could further analyze southern Delta salinity issues and water circulation to identify specific actions that could be implemented to improve southern Delta salinity. The program of implementation includes monitoring, special studies, and reporting to identify actions that will fully address the impacts of the SWP and CVP export operations on water level and flow conditions that may affect salinity conditions in the southern Delta. Based on the information contained in Appendix E, the State Water Board believes there is adequate science at this time to refine the numeric salinity objective for the southern Delta. This SED analyzes the environmental impacts of a range of salinity objectives, expressed as a maximum 30-day running average of mean daily EC in dS/m. The State Water Board's SDWQ alternatives are presented in Table 3-10, and a more detailed description of these alternatives was presented earlier in this chapter (Section 3.4, *Southern Delta Water Quality [SDWQ] Alternatives)*.

Table 3-10. State Water Board's Southern Delta Water Quality (SDWQ) Alternatives

Southern Delta Water Quality Alternatives	Electrical Conductivity Values Analyzed in this SED
SDWQ Alternative 1, No Project Alternative	0.7 dS/m April–August 1.0 dS/m September–March
SDWQ Alternative 2	1.0 dS/m all year
SDWQ Alternative 3	1.4 dS/m all year

dS/m = deciSiemens per meter

Following is a description of the salinity objective recommendations submitted by commenters and a discussion of how they were considered in the development of the SDWQ alternatives.

South Delta Water Agency

In its letter dated May 15, 2009, the South Delta Water Agency (SDWA) submitted comments on the proposed SDWQ modeling alternatives (SDWA 2009) and suggested analyzing longer and more restrictive requirements. The SDWA comments include recommendations for the State Water Board to analyze salinity objectives at Vernalis (C-10) and three interior compliance locations (P-12, C-8, and C-6). These SDWA recommendations (Recommendations 1–3) are listed below.

1. 0.65 dS/m April–August.
2. 0.65 dS/m April–October.
3. 0.70 dS/m April–October.

In addition to these analyses, SDWA recommended the State Water Board analyze salinity objectives under dry conditions at Vernalis (C-10) and three interior compliance locations (P-12, C-8, and C-6). The dry condition SDWA recommendations (Recommendations 4–6) are listed below.

4. 0.65 dS/m March–August.
5. 0.65 dS/m March–October.
6. 0.70 dS/m March–October.

It was determined in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*, that existing water quality in the southern Delta was adequate for all agricultural crops. Based on steady-state soil water salinity analysis and published crop salt tolerance information, Appendix E concludes that salinity levels in the range of 0.9 dS/m–1.1 dS/m in irrigation water appear to be reasonably protective of the most salt-sensitive crops grown in the southern Delta. One of the State Water Board's goals for the plan amendments is to develop objectives that are not lower than necessary to reasonably protect the most salt sensitive crops currently grown or suitable to be grown on saline- and drainage-impaired soils in the southern Delta; therefore, this SED does not evaluate alternatives that provide more protection than is needed for the reasonable protection of the beneficial uses. Therefore, no SED alternative evaluates objectives less than the current objectives (i.e., those in the 2006 Bay-Delta Plan).

Contra Costa County Department of Conservation and Development

The CCCDCD submitted scoping comments on the *Southern Delta Agriculture and San Joaquin River Flows Revised Notice of Preparation* (CCCDCD 2011). The CCCDCD scoping comments included recommendations for the State Water Board to analyze two additional salinity objectives.

1. 0.6 dS/m April–August (as 30-day running average of mean daily) and 0.85 dS/m September–March (as 30-day running average of mean daily) at Vernalis (C-10). 0.7 dS/m April–August (as 30-day running average of mean daily) and 1. 0 dS/m September–March (as 30-day running average of mean daily) at interior compliance locations (P-12, C-8, and C-6).
2. 0.6 dS/m April–August (as 30-day running average of mean daily) and 0.85 dS/m September–March (as 30-day running average of mean daily) at Vernalis (C-10) and interior compliance locations (P-12, C-8, and C-6).

The CCCDCD recommendations are also equal to or less than existing objective levels. It was determined in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*, that existing water quality in the southern Delta was adequate for all agricultural crops. One of the State Water Board's goals for the plan amendments is to develop objectives that are not lower than necessary to reasonably protect the most salt sensitive crops currently grown or suitable to be grown on saline- and drainage-impaired soils in the southern Delta. Therefore, this SED does not evaluate alternatives that provide more protection than is needed for the beneficial uses, and no SED alternative evaluates objectives less than the current objectives in the 2006 Bay-Delta Plan.

San Joaquin River Group Authority

O'Laughlin and Paris LLP reviewed the *Peer Review Draft Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* and prepared comments on behalf of the San Joaquin River Group Authority (SJRGA) (O'Laughlin and Paris LLP 2012). The

SJRGA comments included recommendations for the State Water Board to analyze five additional salinity objectives, which are as follows.

1. 0.7 dS/m March 15–October 31 at interior compliance locations (P-12, C-8, and C-6). Remove the Vernalis (C-10) compliance location.
2. 0.7 dS/m March 15–October 31 at Vernalis (C-10) and interior compliance locations (P-12, C-8, and C-6).
3. 1.0 dS/m March 15–October 31 at Vernalis (C-10). Remove interior compliance locations (P-12, C-8, and C-6).
4. For Recommendations 1–3, modify the salinity objective for April 1–June 31 to be 1.0 dS/cm maximum with a 10-year running average of 0.7 dS/cm at Vernalis (C-10) and interior compliance locations (P-12, C-8, and C-6).
5. For Recommendations 1–3, modify the salinity objective at Vernalis (C-10) for November 1–March 14 to be 1.4 dS/cm maximum with a 10-year running average of 1.2 dS/m. For the same time period, eliminate all salinity objectives at the interior compliance locations (P-12, C-8, and C-6), or set a 1.4 dS/m maximum.

Similar to the State Water Board's SDWQ Alternative 1, the recommendations provided by SJRGA are seasonal water quality objectives. However, unlike the SDWQ alternatives and the other recommendations received, the SJRGA recommendations are only effective for a portion of the year dependent on the recommendation (e.g., SJRGA Recommendations 1, 2, and 3 are only effective March 15–October 31).

SJRGA Recommendations 1, 2, and 3, contain salinity objectives that are encompassed in the SDWQ Alternative 1 objectives. SDWQ Alternatives 1 and 2 encompass the salinity objectives of SJRGA Recommendation 4. SDWQ Alternative 3 encompasses the salinity objectives of SJRGA Recommendation 5. These recommendations do not avoid or lessen any significant impacts and, to the extent they would provide more protection than is needed for the beneficial uses, they do not meet goal 3.

In addition to salinity objectives, SJRGA included specific recommendations pertaining to compliance locations and running averages that were not included in the salinity recommendations received. In SJRGA Recommendation 1, SJRGA recommends the removal of the Vernalis compliance location. Conversely, in SJRGA Recommendations 3 and 5, SJRGA recommends the removal of the interior compliance locations. The Vernalis and the interior compliance locations may not be eliminated because beneficial uses exist there and must be protected. In addition to the elimination of compliance locations, SJRGA Recommendations 4 and 5 included a maximum 10-year running average of 0.7 dS/m and 1.2 dS/m, respectively. The SJRGA recommendations do not provide a technical basis, nor is there one known, for the need to have a 10-year running average. Long averaging periods, longer than a 30-day average, have the potential to cause significant local and seasonal negative effects on crop yields, so does not achieve goal 1 to provide salinity conditions that reasonably protect agricultural beneficial uses of surface waters in the southern Delta.

City of Tracy

In a letter dated May 15, 2009, the City of Tracy recommended that sodium adsorption ratios should be used as the appropriate objective to protect irrigated agriculture instead of EC. The City of Tracy also recommended that experts should be polled as to the constituent(s) of EC that are of concern for irrigated agriculture, and the 2006 Bay-Delta Plan should be modified to remove EC objectives and include objectives only for those problematic constituents of EC (Downey Brand 2009).

Crop stress associated with salinity is caused by the increase in osmotic pressure across the root membranes, which makes it more difficult for plants to uptake water for evapotranspiration. This increase in osmotic pressure is due to the colligative properties of the soil water in the root zone and is not dependent on the type of solute particles, only their concentration. EC has been the standard way of quantifying this property in soil water as used in nearly all of the supporting literature and appears to be an appropriate measure of the relevant soil water properties. Alternatives based on sodium adsorption ratio, or other problematic constituents, do not address factors affecting crop stress (i.e., increased osmotic pressure). Such alternatives do not meet goal 1 of providing salinity conditions that reasonably protect agricultural beneficial uses of surface waters in the southern Delta, a goal that would include protecting against crop stresses such as increases in osmotic pressure.

U.S. Department of the Interior/U.S. Bureau of Reclamation

In its letter dated May 15, 2009, DOI/USBR suggested that the following recommendations be considered in the development and evaluation of the SED alternatives (USBR 2009).

- Add an alternative that includes no salinity objective at Vernalis, or downstream of Vernalis, during the nonirrigation season months.
- Use the modeling process to help identify carryover storage levels in all of the major SJR Basin reservoirs to meet the needs of all beneficial uses (possibly including dilution flows) in the short and long term.
- Include consideration of the Central Valley Water Board's total maximum daily load implementation program, which is based on the Vernalis salinity standard.
- Examine the system through a loading approach as well as a dilution flow approach. A loading approach could also examine the opportunities that other flow requirements provide for exporting salt loads from the basin and the potential for redirected impacts when salinity loads are sequestered in groundwater basins.
- Evaluate how changes to a southern Delta salinity objective may affect water control systems, which in turn could affect the control of coldwater resources and/or the value of fish habitat using a water temperature model for the SJR Basin.

The first recommendation is not an acceptable alternative for evaluation in the SED as it does not provide for protection of beneficial uses in the months of September–March. It, therefore, does not meet an underlying fundamental goal of the plan amendments to reasonably protect agricultural beneficial uses. The recommendations regarding the quantity of dilution flows needed to meet the salinity objective were considered under the No Project Alternative. Modeling of the No Project Alternative, which includes full compliance with current interior southern Delta salinity objectives, shows that approximately 60 TAF/y, on average, would have to be released from New Melones Reservoir to meet the 0.7 dS/m April–August and 1.0 ds/cm September–March objectives in the interior southern Delta (see Table D.3 in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* The other recommendations described above could not be evaluated as alternatives in the SED, as they are recommendations about issues to consider in the cumulative impacts analysis or to consider during implementation of the SDWQ objective.

Stockton East Water District

In its comments received on May 15, 2009, the Stockton East Water District (SEWD) made the following specific recommendations (SEWD 2009).

- A monthly average salinity objective greater than 1.0 dS/m should be modeled to develop appropriate salinity limitations for evaluation.
- A monthly average EC at Vernalis of 1.5 mmhos/cm in all months and a monthly average EC at Brandt Bridge of 1.5 mmhos/cm and 1.8 mmhos/cm in all months should be modeled.
- Include the water year type in establishing the objectives. Modeling should be conducted to determine the effects that water year types have on the salinity objective. It may be appropriate to have differing salinity objectives based on water year type.

Because 1.4 dS/m was the level above which yield impacts became significant for salt sensitive crops, consideration of higher alternatives were not appropriate as the associated beneficial uses would not be adequately protected (Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*). Also, crop salt tolerance is not a function of water year type; therefore, alternatives and modeling based on water year type are not technically appropriate.

Central Delta Water Agency

In its letter dated May 14, 2009, the Central Delta Water Agency (CDWA) provided four general recommendations regarding the SDWQ alternatives (CDWA 2009).

The first recommendation was that the sufficiency of the existing objectives to protect agricultural beneficial uses should be verified, and the existing objectives should be modeled and compared with all other alternatives. The existing objectives should be among the modeled alternatives to see how meeting the existing objectives compares with the other alternatives. This recommendation was incorporated into SDWQ Alternative 1.

The second recommendation was that an objective lower than the current 0.7/1.0 dS/m EC objective (e.g., 0.6/0.9 dS/m EC), should be modeled in the context of the current regime. Also, the existing objectives should be modeled with 0.7/1.0 dS/m EC substituted with 0.7 dS/m EC year-round. Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*, describes that existing water quality in the southern Delta was adequate for all agricultural crops. The State Water Board determined that a goal would be to provide salinity conditions that reasonably protect agricultural uses, but it would not establish objectives that are lower than necessary to reasonably protect the most salt sensitive crops. Thus, alternatives that provided more protection than necessary did not meet the goals and were not considered.

The third recommendation was to include improvements to the southern Delta barrier program to better improve circulation, eliminate stagnant zones, etc., as well as recirculation of water exported from the Delta. USBR studies show limited benefits and significant environmental and economic impacts associated with recirculation so are not included in the SDWQ alternatives. The program of implementation includes requirements for the CVP and SWP projects to develop a coordinated operations plan to address their impact on assimilative capacity in the southern Delta. This coordination operations plan process can address the issues of improved circulation, elimination of stagnant zones, and recirculation.

Finally, CDWA recommended that alternatives should be designed to ensure that the full water supply needs of the New Melones Reservoir area of origin contractors are met. Placing water supply needs above protection of agricultural beneficial uses, however, is inconsistent with the fundamental purpose and goals of the plan amendments. Water supply effects, however, are inherently considered as part of goals 1, 2, and 3.

County of San Joaquin and the San Joaquin County Flood Control and Water Conservation District

In their letter dated May 15, 2009, the County of San Joaquin and the San Joaquin County Flood Control and Water Conservation District made two general comments (Neumiller & Beardslee 2009).

First, the two entities recommended that at least one of the model alternatives needs to include salinity monitoring objectives at locations within the southern Delta and that it is necessary to have Vernalis monitoring and compliance requirements. They recommended that both the interior Delta monitoring locations and the Vernalis monitoring location must remain. The Vernalis monitoring location will continue as a compliance location under the program of implementation for all alternatives. Specific monitoring locations for the interior Delta compliance locations will be determined under the program of implementation. The program of implementation, under all alternatives, provides flexibility on the specific locations and averaging periods. Second, it was recommended that an annual average could lead to "terrible" irrigation season flows being made up for with significantly better winter flows. The salinity objectives recommendation included meeting a minimum monthly compliance requirement and meeting the salinity objective at even more frequent intervals. It is agreed that an annual average objective could allow for unacceptably high concentrations during the growing season. But no information has been provided suggesting that an averaging period of less than a month is necessary. Soil water salinity levels are affected more by average conditions over the growing season than by short-term changes. The historical variability of daily salinity measurements and crop yields does not suggest that variability within a 30-day averaging period has negative effects on crop yields. Shorter averaging periods would require more water to be released to meet the shorter term requirement, so is inconsistent with the goal of considering other water supply demands.

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Chapter 4
Introduction to Analysis

4.1 Introduction

The State Water Resources Control Board (State Water Board) is considering amendments to the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan) that would establish new Lower San Joaquin River (LSJR) flow objectives for the protection of fish and wildlife beneficial uses, revise the southern Delta water quality objectives (SDWQ) for salinity for the protection of agricultural beneficial uses, and establish a program of implementation to achieve those objectives.

This chapter provides an overview of the following topics: modifications made in this recirculated Substitute Environmental Document (SED) since the public draft 2012 SED (2012 Draft SED) was released on December 31, 2012; the framework for analysis; document and chapter organization; terminology used; baseline; and modeling and technical analyses.

4.2 Recirculated SED

The State Water Board has revised and recirculated the 2012 Draft SED released on December 31, 2012. This SED is a recirculated document that makes substantial changes from the 2012 Draft SED in consideration of the large number of oral and written public comments received concerning that document, and in light of additional information, including information stemming from the recent drought and in response to the state's adoption in 2014 of a state policy for sustainable groundwater management (Wat. Code, § 113) and passage of the Sustainable Groundwater Management Act (SGMA) (Wat. Code, §§ 10720 et seq.), which provide for sustainable local groundwater management. A summary of major changes made to address these concerns follows.

The State Water Board received approximately 4000 comments on the 2012 Draft SED during the public comment period (December 31, 2012 to March 29, 2013). The comments received on the 2012 Draft SED are in the administrative record and a summary of the comment letters is found in Appendix M, *Summary of Public Comments on the 2012 Draft SED*. Because the State Water Board is recirculating the entire document, it does not need to respond to the comments on the 2012 Draft SED. Instead, the State Water Board need only respond to comments submitted in response to this recirculated, revised SED. The State Water Board, however, has considered the major themes raised by the comments on the 2012 Draft SED in preparing this revised SED.

4.2.1 Hydrologic Modeling

Comments were received on the 2012 Draft SED regarding the assumptions used in developing the Water Supply Effects (WSE) model and the use of the WSE model to analyze impacts. In response, the WSE model was modified for use in this SED. Changes are summarized below. Appendix F.1, *Hydrologic and Water Quality Modeling*, provides additional details.

- The WSE model was modified to provide a representation of baseline conditions based on and calibrated to CALSIM[1] data but not using the CALSIM model results directly to represent the baseline scenario as was done in the 2012 Draft SED. The WSE model is used independently to simulate both the baseline and the LSJR alternatives for the purpose of analyzing impacts in this SED. The assumptions for the WSE modeled baseline and the LSJR Alternatives 2, 3, and 4 are listed below. All assumptions apply to both the modeled baseline and alternatives, except for the Vernalis Adaptive Management Plan (VAMP) minimum flow requirements (first bullet below, which were only included in the modeled baseline) and LSJR alternative minimum flow requirements, which are applied only in LSJR alternative scenarios.
    - VAMP minimum flow requirements on the Stanislaus and Merced Rivers per the San Joaquin River Agreement (SJRA) (USBR and SJRGA 1999). Water Right Decision D-1641 (D-1641) minimum flow requirements are in effect for February 1–June 30 for both baseline and the LSJR alternatives, although in baseline, D-1641 flows are replaced with the VAMP flow requirement volumes in April and May only.
    - Reasonable and Prudent Alternative (RPA) Action 3.1.3 of the June 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) to the U.S. Bureau of Reclamation (USBR) for the long-term operation of the Central Valley Project (CVP) and the State Water Project (SWP) (Operational Criteria and Plan [OCAP]) minimum streamflows at Goodwin Dam required by BO Appendix 2E as a function of the New Melones Index (NMFS 2009).
    - Stanislaus River maximum CVP diversions based on a 155 thousand acre-feet (TAF) total maximum for Stockton East Water District (SEWD) and Central San Joaquin Water Conservation District (CSJWCD) (USBR 2013a, 2013b), and 600 TAF for South San Joaquin Irrigation District (SSJID) and Oakdale Irrigation District (OID) per the 1988 Stipulation Agreement with USBR (SJRGA 1999).
    - Implementation of LSJR alternative minimum flow requirements as a percent of unimpaired flow[2] February–June during high flow events.
    - Future San Joaquin River Restoration Program (SJRRP)[3] flows are not included.
- The WSE model calculates flow in each tributary as a continuous simulation for all months year-round, including July–January, as opposed to relying on CALSIM output for those months, as was done in the 2012 Draft SED. Streamflows are based on the minimum flow requirements applicable to each tributary and Vernalis, plus any reservoir releases needed to maintain compliance with flood storage curves. The model continues to use estimates of reservoir

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[1] CALSIM is a generalized water resource simulation model for evaluating operational alternatives of the State Water Project (SWP)/Central Valley Project (CVP) system (USBR 2005). CALSIM II is the latest application of the generic CALSIM model to simulate SWP/CVP operations. CALSIM and CALSIM II are products of joint development between the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR). This document uses CALSIM and CALSIM II interchangeably.

[2] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

[3] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future.

inflows, downstream accretions and depletions, and other inputs as developed by USBR for CALSIM.

- The previous WSE modeling in the 2012 Draft SED was configured to closely match the baseline distribution of end-of-September storage levels in the main reservoirs on each tributary. The modified WSE model calculates the amount of water available for diversion each year based on the sum of available end-of-February storage plus March–September inflows, less the sum of March–September river flow requirements and end-of-September minimum storage guidelines (the latter subject to annual drawdown limitations). Available water is then compared against estimates of surface water demand (primarily agricultural irrigation) for the year, with the lesser determining the amount diverted.
- The WSE model has multiple reservoir storage controls to both maintain empty storage capacity for flood control and to maintain carryover storage for coldwater reserves to ensure there are no temperature-related impacts on fisheries during the summer and fall. Reservoir releases for diversion are restricted based on minimum end-of-September storage guidelines in the model. Each year, only a certain percentage of the available water (i.e., the amount above what is required to meet end-of-September storage and in-stream flow requirements) can be released from storage for diversion. This protects storage prior to dry years. In addition, when reservoir levels are low (typically after a dry years) the model limits the amount of inflow that can be used in a subsequent wet year(s) for diversion. By reducing the amount of inflow that can be diverted in such years, reservoirs and associated coldwater pools recover more quickly after dry year(s).
- Diversion demands for major irrigation districts are derived from annually- and monthly-varying Consumptive Use of Applied Water (CUAW) demand estimates from CALSIM, with operational efficiency estimates derived from Agricultural Water Management Plans (AWMPs), and total diversion and use adjusted for best match to AWMP surface water use data. For smaller diversions, CALSIM values are used.
- The WSE model is calibrated to best match to CALSIM baseline diversions, streamflows, and reservoir levels. This exercise demonstrates the WSE model's effectiveness in representing system dynamics similarly to the CALSIM model.
- The water budget quantities in the WSE model are improved and based on published estimates of reservoir losses, municipal and industrial water use, and other factors described in Appendix F.1. The final WSE baseline used in LSJR alternatives analysis includes all of the above changes, but with additional revisions to improved parameters. This differs slightly from the original CALSIM baseline.
- In some water year types, a portion of LSJR alternative instream flow requirement has been "shifted" outside of the February–June period to summer or fall months to avoid temperature impacts caused by lower reservoir levels and to represent one of the methods of adaptive implementation as described in Chapter 3, *Alternatives Description*.
- Maximum streamflows ("flow caps") in downstream reaches have been removed.

4.2.2 Dry Year Evaluation

The 2012 Draft SED analyzed the effects of the flow proposal over an 82-year period of varied hydrology, which included dry years. It did not, however, specifically identify the water supply effects in dry years and consecutive dry years. This SED includes a new chapter Chapter 21, *Drought*

Evaluation, which provides analyses of dry years and multiple dry years. The drought years during the 1922–2003 time period that were modeled using the WSE model are compared with the more recent period of 2004–2015. This new analysis provides an examination and evaluation of the effects of LSJR Alternatives 2, 3, and 4 on reservoir operations and water supply for the more recent drought years from 2012–2015 to verify that water supply effects of drought conditions were accurately calculated and evaluated by the WSE model. It also includes a comparison of available water supply and other parameters during drought periods under baseline conditions and under LSJR Alternatives 2, 3, and 4.

4.2.3 Antidegradation Analysis

The 2012 Draft SED did not contain an antidegradation analysis. This SED contains an antidegradation analysis in Chapter 23, *Antidegradation Analysis*. The antidegradation analysis evaluates LSJR Alternative 3 and unimpaired flows ranging from 20 percent to 60 percent, and SDWQ Alternative 2 to assess the effect of the alternatives on water quality.

4.2.4 Fish Benefits Analyses

This recirculated SED includes Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, which is intended to assist the public with understanding the expected benefits of the LSJR alternatives to native fish. The chapter describes biologically important and measurable benefits of providing higher and more variable flow during the February 1–June 30 time period, with a focus on improved water temperature conditions and enhanced floodplain inundation. The chapter also presents results from a life-history population simulation model (SalSim) for fall-run Chinook salmon originating from the LSJR and the three eastside tributaries[4] to provide insight into population level changes that could be expected under a variety of flow conditions. These new analyses document the ecological linkages between flow, temperature, habitat, and other important criteria for evaluating the expected biological benefits over a range of percent of unimpaired flows encompassed by LSJR Alternatives 2, 3, and 4. The results of the temperature, floodplain, and SalSim evaluations indicate that as the percentage of unimpaired flow increases during the February–June time period, habitat conditions important to native fish can improve dramatically, and the number of adult salmon produced by the the three eastside tributaries would be expected to increase substantially compared to baseline conditions during the time period of 1994–2010.

The fish benefits analyses in Chapter 19 includes the following.

- Discussion of the importance of temperature for key fish species and their lifestages.
- A temperature analysis using San Joaquin River Basin-Wide Water Temperature Model for LSJR Alternatives 2, 3, and 4.
- Discussion of natural flow variation and floodplain inundation for key fish species and their lifestages and a floodplain analysis using the WSE model and floodplain area-versus-flow relationships to evaluate changes in frequency and magnitude of floodplain inundation events for LSJR Alternatives 2, 3, and 4.

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[4] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

- SalSim analysis using WSE model results and temperature model results as input to explore and compare a variety of flow scenarios, including LSJR Alternatives 2, 3, and 4, in terms of modeled population-level responses of fall-run Chinook salmon from the Stanislaus, Tuolumne, and Merced Rivers.
- Discussion of the other expected benefits to native fish and wildlife.

4.2.5 Fish Impact Analyses

In response to comments on the 2012 Draft SED, Chapter 7, *Aquatic Biological Resources*, now analyzes flow impacts (e.g., cumulative distributions of weighted usable area values) based on changes in the magnitude and frequency of modeled flows over the 82-year modeling period instead of using median flows. It also includes a qualitative discussion regarding other fish species and incorporates Instream Flow Incremental Metholology and predation information where appropriate.

4.2.6 Groundwater Effects and Agricultural Resource Modeling

The analysis in the 2012 Draft SED did not attempt to quantify how much of the surface water supply deficit under the LSJR alternatives would be replaced by groundwater supplies. Instead, the 2012 Draft SED analyzed both full replacement by groundwater and no replacement, thereby accounting for the range of possible effects. As described in Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, this recirculated SED now evaluates the likely levels of groundwater replacement, surface water storage and reservoir reoperation, and quantity of surface water deficit not replaced by additional groundwater pumping. This updated analysis relies on new information provided by the water districts and is reflective of additional groundwater pumping capacity developed during recent drought years. Although this approach is intended to reasonably identify the most likely balance between water supply deficit and additional groundwater pumping, the precise balance is unknowable. The updated results from the groundwater pumping analysis are used in Chapter 9, *Groundwater Resources,* Chapter 13*, Service Providers,* and Chapter 22*, Integrated Discussion of Potential Municipal and Domestic Water Supply Management Options.*

This recirculated SED also uses the Statewide Agricultural Production (SWAP) model to perform an agricultural economic analysis. SWAP, an agricultural production model, is used to estimate the direct revenue and crop production effects associated with changes in applied water for agriculture, which is similar to how it was used in the 2012 Draft SED. However, as described in Appendix G, the results of the WSE model are post-processed differently, and the geographic boundaries for the SWAP analysis differ from the 2012 Draft SED. The geographic boundaries used in the SWAP modeling were refined from the 2012 Draft SED to include six geographic areas representing the different irrigation districts that could be most affected by the LSJR alternatives, rather than one aggregated region. Estimates of applied water are determined based on surface water diversions calculated in the WSE model and on groundwater pumping to replace surface water deficit calculated in the groundwater analysis. The applied water estimates are used, along with crop distributions from the California Department of Water Resources (DWR), as inputs for SWAP to estimate agricultural production and associated revenues under baseline conditions and LSJR Alternatives 2, 3, and 4. The changes to the agricultural economics analysis and the additional inputs to the SWAP model provide a more refined analysis, while taking into account potential groundwater pumping.

4.2.7 City and County of San Francisco Water Operations and Supply Analyses

The 2012 Draft SED contained a limited evaluation of the City and County of San Francisco (CCSF) water operations and supply. This SED includes additional analyses to address potential impacts on CCSF in Appendix L, *City and County of San Francisco Analyses,* Chapter 13, *Service Providers*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions*. This appendix and these chapters generally describe how CCSF's water supply could be affected by the flow objectives; quantifies potential water supply effects on CCSF ; describes water transfers and other actions CCSF could take to meet water supply demand if water supplies are reduced; and summarizes the potential economic effects of water supply changes associated with a water transfer.

4.2.8 Effects of the Flow Proposal on Municipal Water Supplies

This SED includes a new chapter, Chapter 22, *Integrated Discussion of Potential Municipal and Domestic Water Supply Management Options*, summarizing the overall effect the project is expected to have on drinking water. This new chapter synthesizes information from other resource chapters, including Chapter 2, *Water Resources*, Chapter 9, *Groundwater Resources*, Chapter 13, *Service Providers*, and Chapter 21, *Drought Evaluation*, in order to provide an integrated discussion of how drinking water supplies would be affected by the plan amendments[5]. The chapter discusses both the initial effects and the potential long-term changes that could occur when SGMA is fully implemented.

4.2.9 Economic Analyses

Chapter 20, *Economic Analyses*, of this recirculated SED summarizes the economic effects associated with the LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3. The information in Chapter 20 is derived from various locations in this SED, including: Chapter 10, *Recreational Resources and Aesthetics*; Chapter 13, *Service Providers*; Chapter 16, *Evaluation of Other Indirect and Additional Actions;* Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*; Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results;* and, Appendix L, *City and County of San Francisco Analyses*. Chapter 20 (as well as the other chapters and appendices that it relies on) contains the following new analyses that were not included in the 2012 Draft SED.

- Fiscal analysis associated with regional agricultural effects under the LSJR alternatives.
- Cost evaluation of municipal and industrial water supplies and affected regional economies under the LSJR alternatives.
- Cost evaluation of additional actions (e.g., non-flow measures[6]) under the LSJR alternatives.

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[5] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

[6] Depending on the context, the terms *non-flow measures* and *non-flow actions* may be used interchangeably in this document.

- Evaluation of potential use and non-use benefits associated with supporting and maintaining sustainable Chinook salmon populations in the three eastside tributaries under the LSJR alternatives.
- Regional economic analyses for CCSF under the LSJR alternatives using Impact Analysis for Planning (IMPLAN).

In addition, the agricultural economic analysis was refined using IMPLAN model multipliers to estimate total (direct, indirect, and induced) economic impacts on employment and regional economic output associated with changes in agricultural production. The discussion describes the effects on all inter-connected sectors of the regional economy.

4.2.10 Plan Area

The plan area and extended plan area are described in Chapter 1, *Introduction*. The plan area encompasses the areas where the proposed plan amendments apply to protect the beneficial uses. In addition to the implementation of the plan amendments in the plan area, implementation of the plan amendments also has the potential to affect the Stanislaus, Tuolumne, and Merced River Watersheds above the rim dams.[7] These areas are referred to as the extended plan area.

Impacts in the extended plan area are addressed in the SED as appropriate. As explained in Chapter 5, *Surface Hydrology and Water Quality*, given the small volume of water held in non-hydropower post-1914 rights for consumptive use in the extended plan area compared to the volume held in non-hydropower post-1914 water rights used below the rim dams, most of the effect of implementing LSJR alternatives would occur at, or downstream of, the major rim dams in the three tributaries. As such, the overall analysis of impacts in the SED focuses on the plan area, downstream of the rim dams, where the flow objectives would be implemented at the confluence of the Stanislaus, Tuolumne, and Merced Rivers. The primary means by which the extended plan area reservoirs and rivers might be affected is if water is bypassed by junior water rights holders, in accordance with the rules of priority and applicable law, to achieve the required flows in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.

The impacts of reduced water diversions, reduced reservoir levels, and additional flow to rivers that could occur in the extended plan area under LSJR Alternatives 2, 3, and 4 are qualitatively evaluated. The analysis of the extended plan area generally identifies how the impacts may be similar or different to the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. The extended plan area impacts are primarily discussed in Chapters 5–14 and Appendix B, *State Water Board's Environmental Checklist*. Table 18-2 summarizes any differences between the impact determinations in the plan area and extended plan area.

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[7] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

4.2.11 Alternatives, Adaptive Implementation, and Analysis

The State Water Board has revised the proposed plan amendments in Appendix K, in *Revised Water Quality Control Plan.* Chapter 3, *Alternatives Description*, describes LSJR Alternatives 2, 3, and 4, and SDWQ Alternatives 2 and 3. This SED has been revised to evaluate the impacts of the revised alternatives. Major changes with respect to the SED regarding the revised alternatives are discussed below.

Preferred Alternative

The evaluation of the preferred alternatives was included in Chapter 20, *Preferred LSJR Alternative and SDWQ Alternative* of the 2012 Draft SED. This chapter has been eliminated. The different alternatives are evaluated in a manner to inform the decision makers and the public about the effects associated with each alternative.

No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)

The metrics and criteria used to evaluate the No Project Alternative are changed to be consistent or similar to those used in Chapters 5–14. In addition, where necessary, the analysis references the different LSJR alternatives to provide comparisons to what would occur if an LSJR alternative was not selected.

LSJR Flow Objectives

This SED evaluates four alternatives for LSJR flows during the February–June time frame, including the No Project Alternative (LSJR Alternative 1), and three other LSJR alternatives (LSJR Alternatives 2, 3, and 4). Each of the LSJR alternatives includes an unimpaired flow range (e.g., 30 percent to 50 percent under LSJR Alternative 3), and the ability to adaptively manage flows within this range. LSJR Alternative 2, 3, and 4 also include common elements, such as a the minimum base flow requirement at Vernalis and the monitoring and reporting program, which are discussed in more detail in Chapter 3, *Alternatives Description.*

The program of implementation for LSJR Alternatives 2, 3, and 4 includes adaptive implementation that allows adaptive adjustments to the flow requirements, such as the magnitude and timing of flows, if information produced through monitoring and review processes, or other best scientific information supports that such changes would be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any existing biological goals approved by the State Water Board. Adaptive implementation could optimize flows to achieve the flow objectives while allowing for consideration of other beneficial uses, such as agricultural, municipal, and recreational uses, provided that these other considerations do not reduce intended benefits to fish and wildlife.

Four different methods of adaptive implementation are analyzed under each LSJR alternative. In general, the methods are as follows: method 1, adjusting the required percent of unimpaired flow within the approved range (e.g., increasing or decreasing the percent of unimpaired flow required by 10 percent depending on the LSJR alternative selected); method 2, managing the required percent of unimpaired flow for February–June as a total volume of water; method 3, allowing a portion of the required unimpaired flow to be shifted outside of February–June, depending on the

LSJR alternative selected; and method 4, allowing adjustments in base flow for February–June in the SJR at Vernalis.

While adaptive implementation is a part of LSJR Alternatives 2, 3, and 4, this SED provides an analysis of these alternatives with and without adaptive implementation. This is because adaptive implementation may take place on either a short-term (e.g., monthly or annually) or a longer-term basis, depending on the method, and would require the coordination, and cooperation stakeholders or the State Water Board. It is also possible that, at times, adaptive implementation would not occur. As such, the frequency, duration, and extent to which adaptive implementation would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation.

The methodology sections in the chapters summarize the four methods of adaptive implementation and describe how they are analyzed. Impacts are generally assessed by comparing the baseline flow results with the results for LSJR Alternatives 2, 3, and 4. Typically, the quantitative results included in the figures, tables, and text of the chapters present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). Most chapters incorporate a qualitative discussion of adaptive implementation under each of the LSJR alternatives that includes the potential environmental effects associated with adaptive implementation. To inform the qualitative discussion and account for the variability allowed by adaptive implementation, modeling was performed to predict conditions at 30 percent and 50 percent of unimpaired flow (as reported in Appendix F.1). The modeling also allows some inflows to be retained in the reservoirs until after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects to fish. This variety of modeling scenarios provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. However, some chapters (i.e., Chapter 5, *Surface Hydrology and Water Quality*; Chapter 9, *Groundwater Resources*; Chapter 10, *Recreational Resources and Aesthetics*; Chapter 13*, Service Providers*, and Chapter 14, *Energy and Greenhouse Gases*) provide a more quantitative discussion of adaptive implementation by evaluating modeling results at either 30 percent or 50 percent unimpaired flow, or both. Most of the significant impacts at the 40 percent or 60 percent unimpaired flow are also significant at 30 percent or 50 percent unimpaired flow, respectively. While the impact determination may not change, there may be a slight change to the magnitude of the impact (less severe as the required percent of unimpaired flow decreases), which is described where necessary. Because the analysis includes a wide range of unimpaired flows for each of the LSJR alternatives with adaptive implementation, the analysis inherently covers the different mixes of adaptive implementation methods 1, 2, 3, and 4 that could occur.

Baseline

As described in Section 4.2.1, *Hydrologic Modeling,* the WSE model now represents both baseline and LSJR alternative conditions, whereas previously, in the 2012 Draft SED, CALSIM provided the baseline condition. Section 4.7, *Baseline*, describes the characterization of baseline.

Methods of Compliance and Other Indirect and Additional Actions

The 2012 Draft SED evaluated different methods of compliance in Appendix H, *Supporting Materials for Chapter 16*. This SED modifies the discussion of the methods of compliance for LSJR Alternatives 2, 3, and 4. It also expands the discussion to include other indirect and additional actions that could be undertaken by the regulated community. The methods of compliance evaluated for the LSJR alternatives include the methods listed below.

- Releasing or bypassing flow at existing reservoir or at existing diversion points—flows being released into the rivers to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reoperating reservoirs—modifying reservoir operations to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reducing surface water diversions—reducing surface water diversions to allow for the release or bypass of flows or reoperation of reservoirs meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.

The State Water Board also provides an evaluation of other actions associated with LSJR Alternatives 2, 3, and 4. These include different actions that the regulated community could take to reduce potential reservoir or water supply effects associated with implementing LSJR Alternatives 2, 3, and 4. These actions are evaluated in Chapter 9, *Groundwater Resources*, Chapter 11, *Agricultural Resources*, Chapter 13, *Service Providers*, Chapter 14, *Energy and Greenhouse Gases*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions*, as well as Appendix H, *Supporting Materials for Chapter 16*, and Appendix L, *City and County of San Francisco Analyses*. There are also additional actions (i.e., non-flow measures) that would inform the body of scientific information used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4; these are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.* The other actions are listed below.

- Transfer or sale of surface water.
- Substitution of surface water with groundwater.
- Aquifer storage and recovery.
- Recycled water sources for water supply.
- In-Delta diversions.
- Water supply desalination.
- New surface water supplies.
- Floodplain and riparian habitat restoration.
- Reduce vegetation-disturbing activities in floodplains and floodways.
- Gravel augmentation.
- Enhanced in-channel complexity.
- Improve temperature conditions.
- Fish passage—fish screens (screen unscreened diversions in tributaries and LSJR).
- Fish passage—physical barrier in the southern Delta.
- Fish passage—human-made barriers to fish migration.
- Predatory fish control.
- Invasive aquatic vegetation control.

Cumulative Analysis

Cumulative impacts are analyzed in this SED in Chapter 15, *No Project Alternative* (*LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project Alternative, Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*.

4.3 Analytical Framework

This section describes the analytical framework in this SED used to evaluate the environmental impacts of the LSJR and SDWQ alternatives, as well as economic effects, benefits to fish, and other considerations.

This SED evaluates the potentially significant environmental impacts associated with the LSJR and SDWQ alternatives. The assessment of environmental effects in this SED was conducted at a programmatic level, which is a broader level than a project-specific analysis. The State Water Board's adoption of amendments to the 2006 Bay-Delta Plan will not result in direct physical changes in the environment. Rather, it is through the implementation of the Bay-Delta Plan that physical changes in the environment potentially may occur. Accordingly, all potential environmental effects evaluated in this SED are indirect effects associated with implementation, which would occur later in time and would be subject to project-specific environmental review, in compliance with CEQA.

The evaluation of the impacts of the LSJR and SDWQ alternatives on particular resources is contained in Chapters 5–18 and Appendix B, *State Water Board's Environmental Checklist*. Appendix B is based on the template contained in Appendix A of the State Water Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.)

As required by Public Resources Code Section 21159 and the State Water Board's regulations (Cal. Code Regs., tit. 23, § 3777), this SED evaluates the environmental impacts related to reasonably foreseeable methods of compliance with plan amendments. It programmatically evaluates indirect actions and additional actions, including reasonably foreseeable methods of compliance, in Chapters 5–16*.* Chapter 16, *Evaluation of Other Indirect and Additional Actions,* augments the analyses in the preceding chapters to include an evaluation of the methods of compliance for the SDWQ alternatives. Chapter 16 also evaluates indirect actions that the regulated community may take in response to complying with the LSJR alternatives, such as transferring or selling surface water, substituting surface water with groundwater, practicing aquifer storage and recovery, recycling water sources for water supply, diverting in-Delta water, desalinating for water supply, and utilizing new surface water supplies.

In addition, this SED contains additional information, including economic information, to support evaluations such as those under Public Resources Code, Section 21159 and the Porter-Cologne Water Quality Control Act. (Wat. Code, § 13000 et seq.) For example, Water Code Section 13141 requires an estimate of total cost of an agricultural water quality control program before implementing such a program. This information can be found in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, which provides an evaluation of the agriculture economic-related effects of reduced surface water diversions. Because the State

Water Board wishes to understand the water supply effects associated with LSJR Alternatives 2, 3, and 4, this SED also evaluates the related indirect and induced effects on the regional economy. Chapter 20, *Economic Analyses*, provides a summary of the economic effects of the LSJR and SDWQ alternatives, methods of compliance, and other indirect and additional actions.

4.3.1 Impacts Associated with LSJR Alternatives

The existing water quality objectives identified in the 2006 Bay-Delta Plan would be amended to protect the beneficial uses of fish and wildlife on the three eastside tributaries and the LSJR. Three of the four LSJR alternatives evaluated in this SED include a narrative and numeric objective to establish flow sufficient to support and maintain the natural production of fish populations in the plan area that mimic the natural hydrograph with respect to relative magnitude, duration, timing, and spatial extent of flows. The LSJR alternatives are as follows.

- LSJR Alternative 1, the No Project Alternative, would continue the flow requirements as established in the 2006 Bay-Delta Plan and implemented through D-1641; this also includes continuation of, and full compliance with, the southern Delta salinity objective as described in SDWQ Alternative 1.
- LSJR Alternative 2 would establish a range between 20 and 30 percent, with 20 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 3 would establish a range between 30 and 50 percent, with 40 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 4 would establish a range between 50 and 60 percent, with 60 percent as the starting percentage of unimpaired flow in the program of implementation.

Details of these four LSJR alternatives are provided in Chapter 3, *Alternatives Description*, and the language of the updated 2006 Bay-Delta Plan is included in Appendix K, *Revised Water Quality Control Plan.*

Mechanisms Causing Potential Impacts

The following list summarizes the physical changes that could result from the plan amendments and have the potential for quantifiable impacts on environmental resources.

- River flows—changes in river flows could result in impacts (e.g., reduction in aquatic resource habitat).
- Reservoir operations—changes to reservoir operations could result in impacts.
- Surface water diversions—changes to surface water diversions could result in impacts (e.g., reduction of irrigated agricultural land).
- Groundwater pumping rates—changes to surface water diversions could result in increased groundwater pumping.

The potential environmental impacts of these physical changes are evaluated in Chapters 5–17 of this SED. The agricultural economic effects of surface water diversion reductions are summarized, along with all other economic impacts, in Chapter 20, *Economic Analyses*, and are evaluated in detail in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Methods of Compliance

The following list summarizes the methods of compliance that could be implemented by irrigation districts or reservoir operators to comply with the LSJR alternatives. The potential environmental impacts of these methods of compliance are evaluated further in Chapters 5–17 of this SED. The agricultural economic effects of surface water diversion reductions are summarized, along with all other economic impacts, in Chapter 20, *Economic Analyses*, and are evaluated in detail in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

- Releasing or bypassing flow at existing reservoir or at existing diversion points—flows being released into the rivers to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reoperating reservoirs—modifying reservoir operations to meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.
- Reducing surface water diversions—reducing surface water diversions to allow for the release or bypass of flows or reoperation of reservoirs meet the unimpaired flows as defined by the LSJR alternatives with or without adaptive implementation.

Other Indirect and Additional Actions

The following list summarizes the other indirect and additional actions that could be implemented by irrigation districts, water districts, or municipalities to respond to the LSJR alternatives and methods of compliance.

- Transfer/sale of surface water—water transfers or sales between water users.
- Substitution of surface water with groundwater—construction and operation of new groundwater wells.
- Aquifer storage and recovery—increased conjunctive groundwater use by agricultural and municipal and industrial water suppliers.
- Recycled wastewater sources for water supply—construction and operation of new recycled wastewater facilities or increased utilization of existing facilities.
- In-Delta diversions—construction and operation of new in-delta diversion for SFPUC service area.
- Water supply desalination—construction and operation of desalination plant for SFPUC service area.
- New surface water supplies—construction and operation of new surface water reservoirs.
- Floodplain and riparian habitat restoration—actively restoring floodplain or riparian habitat adjacent to rivers by creating or expanding existing natural or engineered floodways or flood bypasses; modifying river or floodplain geometry; planting riparian vegetation; hydrologically reconnecting historic floodplain; or removal or riprap.
- Reduce vegetation-disturbing activities in floodplains and floodways—actions may be included among discretionary or non-discretionary permit conditions, guidelines, or policies governing existing levee and floodway maintenance activities, as well as implementation of floodplain,

floodway, or riparian management and restoration plans in areas adjacent or within the Stanislaus, Tuolumne, and Merced River channels.

- Gravel augmentation—artificially adding spawning-size gravel to streams by adding gravel to streams; modifying river and then adding gravel to streams; or adding larger structures to river to create hydraulic conditions conducive to gravel deposition and retention.
- Enhanced in-channel complexity—placement of large wood or boulder structures in rivers.
- Improve temperature conditions—installation or modification of temperature curtains or shutters in reservoirs.
- Fish passage—fish screens (screen unscreened diversions in tributaries and LSJR)—Screen existing unscreened diversions with different types of screens in accordance with established design, operational, and maintenance criteria and guidelines from wildlife and resource agencies.
- Fish passage—physical barrier in the southern Delta—construction and operation of a permanent operable barrier at the e Head of Old River (HORB) barrier in the Southern Delta.
- Fish passage—human-made barriers to fish migration—feasibility and design studies to explore the feasibility of modifying existing barriers on the three eastside tributaries that restrict fish migration, including trucking and hauling and elevators.
- Predatory fish control—directly remove known predators within the Delta or three eastside tributaries or modify habitat to remove predator habitat.
- Invasive Aquatic Vegetation Control—small scale and large scale applications of herbicides in the Delta and small scale mechanical removal of invasive species in the Delta.

A site-specific, project-level analysis of these actions is not possible due to uncertainty about timing, duration, and magnitude of the actions. Therefore, a conceptual environmental evaluation and cost evaluation are provided primarily in Chapter 16, *Evaluation of Other Indirect and Additional Actions*. Chapter 9, *Groundwater Resources*; Chapter 11, *Agricultural Resources*; Chapter 13, *Service Providers*; Chapter 14, *Energy and Greenhouse Gases*, as well as Appendix H, *Supporting Materials for Chapter 16*, and Appendix L, *City and County of San Francisco Analyses* also provide some evaluation. Cost evaluations associated with these actions are summarized with all other economic impacts in Chapter 20, *Economic Analyses*, and Appendix L, *City and County of San Francisco Analyses*. Many of the actions described above may require permits or other approvals from other agencies prior to implementation. Their inclusion in this SED does not equate to an expression of jurisdiction over, or approval by, the State Water Board.

4.3.2 Impacts Associated with SDWQ Alternatives

The SDWQ alternatives would amend the existing water quality objectives for salinity identified in the 2006 Bay-Delta Plan to protect agricultural beneficial uses in the southern Delta. The alternatives evaluated in this SED are listed below.

- SDWQ Alternative 1, the No Project Alternative, would continue the existing salinity (electrical conductivity [EC][8]) objective as 1.0 deciSiemens per meter (dS/m) September–March and 0.7 dS/m April–August in the southern Delta; include continued conditioning of the DWR's and USBR water rights to meet the objectives at certain locations.
- SDWQ Alternative 2 would establish a numeric salinity objective of 1.0 dS/m as a maximum 30-day running average of mean daily EC for all months in the SJR between Vernalis and Brandt Bridge, Middle River from Old River to Victoria Canal, and Old River/Grant Line Canal from the Head of Old River to West Canal. The SJR at Airport Way Bridge near Vernalis compliance location would not change. Revised D-1641 imposes conditions on USBR's water rights requiring implementation of EC levels of 0.7 mmhos/cm from April–August and 1.0 mmhos/cm from September–March at Vernalis (units of mmhos/cm are equal to units of dS/m). USBR would continue to be required to comply with these salinity levels, as a condition of their water rights, in order to implement and meet the proposed salinity water quality objectives in the interior southern Delta.
- SDWQ Alternative 3 is similar to SDWQ Alternative 2 but would establish a salinity objective of 1.4 dS/m maximum 30-day running average of mean daily EC for all months for the southern Delta and include continued conditioning of USBR water rights to meet its current salinity D-1641 compliance requirement at Vernalis. The compliance locations and all other provisions of SDWQ Alternative 3 are the same as for SDWQ Alternative 2.

Details of these three SDWQ alternatives are provided in Chapter 3, *Alternatives Description*, and the language of the amended Bay-Delta Plan is included in Appendix K, *Revised Water Quality Control Plan.*

Mechanisms Causing Potential Impacts

The following summarizes the physical changes that could result from the SDWQ alternatives and have the potential for impacts on environmental resources and the economy.

- EC/salinity concentrations—changes in surface water EC resulting from the LSJR or SDWQ alternatives could result in impacts.

The potential environmental impacts of these physical changes are evaluated in Chapters 5–17 of this SED. The associated economic impacts were evaluated and summarized together with all other economic impacts in Chapter 20, *Economic Analyses.*

Methods of Compliance

The following summarizes the potential methods of compliance that could be implemented by municipalities, agricultural producers, and the CVP and SWP to comply with the SDWQ alternatives. A site-specific, project-level analysis of these potential methods of compliance is not possible due to uncertainty about which actions would be taken, and the timing, duration, and magnitude of the actions. Therefore, a conceptual environmental evaluation of these methods of compliance and

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[8] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

a cost evaluation of each are provided in Chapter 16, *Evaluation of Other Indirect and Additional Actions*. Economic impacts associated with these methods of compliance are summarized with all other economic impacts in Chapter 20, *Economic Analyses*. Many of the actions described below may require permits or other approvals from other agencies prior to implementation, and their inclusion in this SED does not equate to an expression of jurisdiction over, or approval by, the State Water Board.

Municipal Wastewater Treatment Plants

Although other actions could be undertaken, it is reasonably foreseeable that municipalities would take one or more of the following actions to comply with National Pollutant Discharge Elimination System (NPDES) effluent limits established by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), which would use the numeric salinity objectives in the SDWQ alternatives.

- New source water supplies—develop and utilize alternate low-salinity municipal water supplies.
- Salinity pretreatment programs—implement industrial and residential salinity source controls.
- Desalination—construct and operate salinity removal facilities at municipal wastewater treatment plants.

Agricultural Producers

Although other actions could be undertaken, it is reasonably foreseeable that drainage districts and/or farmers would take the following action to control salinity loads in agricultural return flows to comply with salinity load allocations.

- Real-time management—Shift the agricultural discharge timing such that the agricultural return flow released from agricultural lands would occur during times of high assimilative capacity for the receiving waters. This would require the construction and operation of detention ponds.

CVP and SWP

Although they could undertake other actions, it is reasonably foreseeable that DWR for SWP operations and USBR for CVP operations would take the following actions to comply with the water level and flow conditions of the SDWQ alternatives in the event that such modifications are warranted.

- Continuation of the Temporary Barriers Program—continuation of the existing program of four temporary barriers (three for agriculture, one for fish) for an unknown duration.
- Low-lift pumping stations—construct and operate either temporary or permanent pumping system(s) near the Middle River, Grant Line Canal, and/or Old River at Tracy Temporary Barriers Project in the southern Delta.

4.4 Chapter Organization

This section describes how the chapters in this SED are organized, the type of information they contain, and where information can be found.

4.4.1 Resource Chapters

The discussion in Chapters 5–14 is divided into several parts, including an introduction, a description of the environmental and regulatory setting, and analysis of environmental impacts.

Introduction

The introduction provides an overview of the existing environmental setting and impacts evaluated for the resource. A summary of the impacts on the resource is presented in a table at the end of the introduction. These tables provide each impact statement for the resource, summarize the impacts and their levels of significance in relation to each of the LSJR or SDWQ alternatives, and identify the significance determination after implementation of all feasible mitigation. This information is also summarized in Chapter 18, *Summary of Impacts and Comparison of Alternatives*, Tables 18-1, 18-2, and 18-3.

Environmental Setting

The environmental setting section provides a historical perspective and a detailed description of the current conditions for the resource. This section also presents specific baseline information, including information obtained from published environmental documentation, books, websites, research and journal articles, and personal communications with field experts.

Regulatory Background

The regulatory background section lists and describes laws, regulations, and policies that are relevant to the State Water Board's plan amendments, the assessment of impacts, or development of mitigation. Often, as in aquatic or terrestrial biological resources, the regulatory framework is the basis for the conclusion of the level of significance and, therefore, plays a role in impact assessment.

Environmental Impacts

A reasonable range of alternatives are evaluated in this SED to show differences in environmental consequences of the alternatives. The alternatives are feasible and satisfy the objectives and goals of amending the 2006 Bay-Delta Plan. This SED analyzes all alternatives identified in Chapter 3, *Alternatives Description*.

Thresholds

The thresholds section describes thresholds of significance used for the resource to determine the significance of impacts as required in an SED.

Methods and Approach

The methods and approach section in the resource chapters describes the resource-specific assessment methods, approach, and analytical models used to identify and evaluate the environmental impacts for the resource. It also describes any specific significance criteria used in the assessments to determine the level of significance of an impact. It also describes how the four methods of adaptive implementation are integrated into the analysis of the resource and what information is used to evaluate adaptive implementation.

Mitigation Measures

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777 (b)(d).) Feasible mitigation measures are intended to avoid, reduce, or compensate for adverse impacts on a resource. For each impact identified as significant, a mitigation measure to reduce that impact to a less-than-significant level is described, if appropriate, or the infeasibility of mitigation is discussed.

4.4.2 No Project Alternative Impacts

Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)* and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, discuss the No Project Alternative. As State CEQA Guidelines Section 15126.6(e)(3)(A) states, “when the project is revision of an existing regulatory plan ... the ‘no project' alternative will be the continuation of the existing plan ... into the future.” The No Project Alternative represents the likely future conditions without adoption and implementation of the flow or salinity amendments to the 2006 Bay-Delta Plan. The No Project Alternative assumes continued implementation of the 2006 Bay-Delta Plan, which includes flow objectives implemented through D-1641 and flow objectives to comply with the salinity objective for the SJR at Vernalis and the three interior compliance stations (Brandt Bridge on the SJR, Old River near Middle River, and Old River at Tracy Road Bridge). Chapter 15 describes LSJR Alternative 1 and SDWQ Alternative 1, summarizes technical results, and describes the environmental impacts of LSJR Alternative 1 and SDWQ Alternative 1. Appendix D presents the technical assumptions for the No Project Alternative. Because the No Project Alternative is discussed in Chapter 15 and Appendix D, any reference to LSJR alternatives or SDWQ alternatives in Chapters 5–14 refers to LSJR Alternatives 2, 3, or 4, or SDWQ Alternatives 2 and 3, respectively.

4.4.3 Evaluation of Other Indirect and Additional Actions

Chapter 16, *Evaluation of Other Indirect and Additional Actions*, discusses those other indirect and additional actions that could occur under the LSJR alternatives and the methods of compliance that could occur under the SDWQ alternatives, as described below.

LSJR Alternatives

Chapter 16 describes actions that the regulated community could take to reduce potential reservoir or water supply effects associated with implementing LSJR Alternatives 2, 3, and 4The cost and potential environmental effects of these actions are programmatically evaluated in this chapter using reference projects, standard assumptions regarding the type and potential location of these measures, and impact mechanisms likely to occur under these activities. Potential mitigation measures are proposed for those actions that may have potentially significant environmental impacts.

- Transfer/sale of surface water.
- Substitution of surface water with groundwater.
- Aquifer storage and recovery.
- Recycled water sources for water supply.
- In-Delta diversions.
- Water supply desalination.
- New surface water supplies.

Chapter 16 also describes actions that would inform the body of scientific information potentially used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4 (i.e., non-flow actions).The cost and potential environmental effects of non-flow actions are programmatically evaluated using reference projects, standard assumptions regarding the type and potential location of these actions, and impact mechanisms likely to occur under these actions. The non-flow actions are listed below. Potential mitigation measures are proposed for those actions that may have potentially significant environmental impacts.

- Floodplain and riparian habitat restoration.
- Reduce vegetation-disturbing activities in floodplains and floodways.
- Gravel augmentation.
- Enhanced in-channel complexity.
- Improve temperature conditions.
- Fish passage—fish screens (screen unscreened diversions in tributaries and LSJR).
- Fish passage—physical and non-physical barriers in the southern Delta.
- Fish passage—human-made barriers to fish migration.
- Predatory fish control.
- Invasive species control (i.e., plant control).

SDWQ Alternatives

Chapter 16 also describes the methods of compliance that could be undertaken by the regulated community to comply with the SDWQ alternatives. The cost and potential environmental effects of these methods of compliance are programmatically evaluated using reference projects, standard assumptions regarding the type and potential location of these measures, and impact mechanisms likely to occur under these measures. The methods of compliance are listed below. Potential mitigation measures are proposed for those that may have potentially significant environmental impacts.

- New source water supplies.
- Salinity pretreatment programs.

- Desalination.
- Agricultural return flow salinity control.
- Southern Delta temporary barriers.
- Low-lift pumping stations.

Finally, Chapter 16 provides a brief summary of the federal and state sources of funding that could be used for those actions that could occur under the LSJR or SDWQ alternatives.

4.4.4 Cumulative and Growth-Inducing Impacts

Cumulative impacts are analyzed in this SED in Chapter 15, *No Project Alternative* (*LSJR Alternative 1 and SDWQ Alternative 1)*, Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*.

4.5 Terminology

The following terms are used in this SED.

- No impact: No adverse changes in the environment are expected.
- Less-than-significant impact: The alternative would not result in a substantial adverse change in the environment (i.e., the impact would not reach the threshold of significance). Mitigation is not required.
- Significant: The alternative would result in a substantial, or potentially substantial, adverse change in the environment (i.e., the impact exceeds the applicable significance threshold established by the State Water Board). Mitigation measures or alternatives to the project must be provided, if feasible, in an attempt to reduce or avoid significant impacts.
- Significant and unavoidable: The alternative would result in a substantial adverse change in the environment, and there are no feasible alternatives or mitigation measures that would substantially lessen the impact to a less-than-significant level.
- Mitigation: Mitigation refers to measures that would be implemented to avoid or lessen potentially significant impacts. Mitigation measures would be proposed as a condition of plan approval and would be monitored to ensure compliance and implementation. Mitigation includes the following effects. (Cal. Code Regs., tit. 14, § 15370.)
    - Avoiding the impact altogether by not taking a certain action or parts of an action.
    - Minimizing the impact by limiting the degree or magnitude of the action and its implementation.
    - Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
    - Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
    - Compensating for the impact by replacing or providing substitute resources or environments.

4.6 Scope of Analysis

In developing the scope of the environmental analysis, , the State Water Board considered the potential effects of the proposed plan amendments, comments received in response to the notice of preparation (NOP) and during public consultation, other public comments and information, and the environmental issues identified in Appendix A of the State Water Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The State Water Board's determinations regarding impacts that are not potentially significant and that are not addressed detail in this SED are explained in Appendix B, *State Water Board's Environmental Checklist*. The following chapters evaluate environmental impacts.

- Chapter 5: *Surface Hydrology and Water Quality*
- Chapter 6: *Flooding, Sediment, and Erosion*
- Chapter 7: *Aquatic Biological Resources*
- Chapter 8: *Terrestrial Biological Resources*
- Chapter 9: *Groundwater Resources*
- Chapter 10: *Recreational Resources and Aesthetics*
- Chapter 11: *Agricultural Resources*
- Chapter 12: *Cultural Resources*
- Chapter 13: *Service Providers*
- Chapter 14: *Energy and Greenhouse Gases*
- Chapter 15: *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*
- Chapter 16: *Evaluation of Other Indirect and Additional Actions*
- Chapter 17: *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*
- Chapter 18: *Summary of Impacts and Comparison of Alternatives*

Each resource chapter describes the criteria or thresholds of significance used to evaluate the environmental impact and the significance determinations.

Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, describes biologically important and measurable benefits of providing higher and more variable flow during the February 1–June 30 time period, with a focus on improved water temperature conditions and enhanced floodplain inundation. This chapter is provided to assist the public with understanding the expected benefits of the LSJR alternatives to native fish. It does not evaluate impacts.

Several technical appendices support the analysis in the SED chapters.

- Appendix A: *NOP Scoping and Other Public Meetings*
- Appendix B: *State Water Board's Environmental Checklist*
- Appendix C: *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*

- Appendix D: *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*
- Appendix E: *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*
- Appendix F.1: *Hydrologic and Water Quality Modeling*
- Appendix F.2: *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*
- Appendix G: *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives*
- Appendix H: *Supporting Materials for Chapter 16*
- Appendix I: *Cultural Resources Overview*
- Appendix J: *Hydropower and Electric Grid Analysis of Lower San Joaquin River Flow Alternatives*
- Appendix K: *Revised Water Quality Control Plan*
- Appendix L: *City and County of San Francisco Analyses*
- Appendix M: *Summary of Public Comments on the 2012 Draft SED*

Appendix B, *State Water Board's Environmental Checklist*, also identifies and explains why the alternatives would result in either no impacts or less-than-significant impacts on particular resources.

4.7 Baseline

CEQA requires a description of the physical environmental conditions in the vicinity of the project as they exist at the time the NOP is published (February 13, 2009), or if no NOP is published, at the time environmental analysis is commenced. (Pub. Resources Code, § 15125.) This environmental setting will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant. In general, the baseline used in this SED reflects the physical environmental conditions in 2009 as they existed under the 2006 Bay-Delta Plan, as implemented through D-1641. The WSE modeled baseline (as described in Appendix F.1, *Hydrologic and Water Quality Modeling*) allocates flow to comply with the 2006 Bay-Delta Plan flow objectives and other requirements that existed in 2009, including implementation of VAMP (which ended in 2011), the NMFS BO flow requirements on the Stanislaus River, FERC flow requirements on the Tuolumne River and on the Merced River, the Davis-Grunsky Contract between the State of California and Merced Irrigation District, and the Cowell Agreement. The baseline does not include the long-term SJRRP flow requirements, although these conditions are considered in the cumulative impacts analysis. Periodic exceedances of the interior southern Delta salinity objectives occur in the historical record, and likewise remain in the modeled baseline condition.

Each chapter describes the existing environmental conditions relevant to a particular resource. The baseline pertinent to each of the resource areas is included in the environmental setting section of each resource chapter. Below is a description of how different resource parameters may vary over time and how they may be incorporated into baseline conditions.

The environmental conditions in the Bay-Delta and SJR Basin are determined by numerous complex interactions and changing conditions. Defining baseline is challenging in such a variable environment. To take into account natural variability, while still representing shifts that have occurred over time, baseline conditions for surface hydrology, water diversions, water quality, aquatic resources, and other relevant resources are characterized based on recent historical conditions. The recent historical period used in the analysis differs for each resource considered, depending on the availability and suitability of data to represent existing conditions. Since hydrologic conditions vary naturally from year to year, sometimes dramatically, parameters strongly dependent on hydrology, such as water supply, are simulated using the WSE model for the long-term period of record 1922–2003 at the present level of development, an approach derived from CALSIM II, including the assumption that the major reservoirs were in existence for this entire period. Recent data and published reports in combination with WSE model output are also used to estimate baseline conditions for water supply.

Other parameters, such as cultural resources, also change over time but do not exhibit significant annual variability. These types of parameters are defined by the conditions present at the time the NOP was issued. This may be constrained in some instances by data availability; in those instances, the most current readily available information is used. It should be noted that a second NOP was released on April 1, 2011. This SED considers the relevance of changes of information that may have occurred since the issuance of the 2009 NOP, where appropriate.

Regulatory requirements, which may also affect existing conditions (e.g., surface water hydrology), are subject to change. Baseline conditions generally represent long-term flood control, water management, environmental, and other requirements applicable to the major water projects. These requirements are discussed in more detail in each appropriate chapter. Modeling and Technical Analyses

This SED relies on numerous modeling and technical analyses to describe and evaluate baseline conditions and impacts. This section provides a brief overview of the types of modeling and technical analyses performed. It identifies the chapters and appendices that describe this information in more detail and the chapters that primarily use the results of the modeling and technical analysis to determine impacts.

4.7.1 Peer-Reviewed Scientific Basis Report

The scientific basis of any statewide plan, basin plan, plan amendment, guideline, policy, or regulation must undergo external peer review before adoption by the state or regional board (Health and Safety Code, § 57004.) State Water Board staff, in accordance with Health and Safety Code Section 57004, submitted a peer review request for the report titled, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow Objectives for the Protection of Fish and Wildlife Beneficial Uses and Water Quality Objectives for the Protection of Southern Delta Agricultural Beneficial Uses and the Program of Implementation for Those Objectives* (included in this document as Appendix C, *Technical Report On The Scientific Basis For Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*). This technical report provides the scientific basis for the LSJR and SDWQ alternatives. Also included as attachments to Appendix C are the peer reviews and a summary of the State Water Board staff's response.

4.7.2 Hydrologic and Water Quality Modeling

The analysis in this SED relies on the modeling output and results of the State Water Board's WSE model, which is described below. In addition, a temperature model was used to determine temperature changes as a result of the LSJR alternatives.

Water Supply Effects Model

The WSE model is a monthly water balance spreadsheet model based on the CALSIM II analysis framework that calculates for each tributary reductions in water supply diversions and changes in reservoir operations that could occur based upon user-defined diversion and reservoir operating rules, flood storage curves, and minimum river flow requirements, across 82 years of monthly historical watershed hydrology. The model estimates the amount of water available for diversion each year, based on the difference between estimates of available water for the year and the amount needed to satisfy downstream flow and other requirements. Available water is then compared to estimates of demands (primarily agricultural irrigation) for the year, with the lesser determining the amount diverted. The model uses estimates of reservoir inflows, downstream accretions and depletions, and other inputs as developed by DWR and USBR for the CALSIM model.

Appendix F.1, *Hydrologic and Water Quality Modeling*, provides a detailed description of the WSE model and the results from the modeling. Chapter 5, *Surface Hydrology and Water Quality*, also provides a summary of the WSE model and uses the modeling results to establish baseline conditions and analyze LSJR and SDWQ alternative surface hydrology and water quality impacts. Additional chapters, such as Chapter 7, *Aquatic Biological Resources*; Chapter 8, *Terrestrial Biological Resources*; Chapter 10, *Recreational Resources and Aesthetics*; Chapter 11, *Agricultural Resources*; and Chapter 13, *Service Providers*, use the WSE model-predicted river flows and diversion modifications to evaluate impacts on various environmental resources.

Temperature Model

To model effects on temperature in the LSJR and three eastside tributaries, the State Water Board modified the SJR Basin-Wide Water Temperature Model (temperature model), a model using the Hydrologic Water Quality Modeling System (HWMS-HEC5Q), a graphical user interface that employs the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) flow and water quality simulation model, HEC-5Q. The SJR temperature model was developed by the California Department of Fish and Wildlife (CDFW) and a group of consultants between 2003 and 2013 funded through a series of CALFED Bay-Delta Program contracts that included peer review and refinement (CALFED 2009; CDFW 2013). The temperature model was used to accurately simulate temperature for a range of reservoir operations, river flows, and meteorology. To determine effects of the LSJR alternatives on river temperatures, this model was adapted to run with streamflows from WSE model representations of the alternatives and baseline, with the resulting temperatures compared at key locations along each tributary.

Appendix F.1, *Hydrologic and Water Quality Modeling*, provides a detailed description of the temperature model and the modeling results. Chapter 5, *Surface Hydrology and Water Quality*, also provides a summary and uses modeling results to establish baseline conditions. Chapter 7, *Aquatic Biological Resources*, uses the temperature results to evaluate impacts on aquatic resources and Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30* to inform the benefits to temperature under the LSJR alternatives.

4.7.3 Agricultural and Economic Modeling

The WSE model estimates the amount of surface water diversion for the LSJR alternatives and baseline for agricultural irrigation across 82 years of historical watershed hydrology. These diversion estimates are used in the SWAP model to estimate the agricultural production and revenues associated with each of the LSJR alternatives and baseline. The SWAP model was selected to estimate the agricultural production (crop acreages) and revenues (total production value) associated with the surface water diversions under the LSJR alternatives and baseline conditions. SWAP is an agricultural production model that simulates the decisions of farmers at a regional level based on principles of economic optimization. The model assumes that farmers maximize profit (revenue minus costs) subject to resource, technical, and market constraints. The model selects those crops, water supplies, and irrigation technology that maximize profit subject to these equations and constraints. The model accounts for land and water availability constraints given a set of factors for production prices and calibrates exactly to observed yearly values of land, labor, water, and supplies use for each region.

The results of SWAP were then used as inputs for IMPLAN. IMPLAN is an input-output multiplier model that considers interrelationships among sectors and institutions in the regional economy. Production in the different economic sectors is simulated in IMPLAN by using fixed factors. The model then applies these factors in a matrix that accounts for changes in transactions between producers and intermediate and final consumers in other sectors of the economy. The IMPLAN approach also considers nonmarket transactions, such as unemployment insurance payments and associated changes in tax revenues for government.

Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, provides a detailed description of SWAP and IMPLAN and their results. Chapter 11, *Agricultural Resources*, and Chapter 20, *Economic Analyses*, use the results of SWAP to analyze potential impacts of the LSJR alternatives on agricultural resources and economics, respectively.

4.7.4 SalSim

SalSim is a life-history population simulation model for fall-run Chinook salmon originating from the Stanislaus, Tuolumne, and Merced Rivers, and is used to evaluate the effects of potential water management scenarios on salmon from these rivers. SalSim was developed by CDFW (2014), and is intended as a user-friendly web-based application. Users can interactively perform simulation runs for different water management scenarios, view results on the screen (GUI output) and download results for further analysis using third party software, such as HEC-DSS (USACE Data System Storage) and Microsoft Excel (via CSV output files). SalSim can also use external data generated by other basin-wide operational and/or water temperature models, such as CALSIM II, the WSE model, and the San Joaquin River Basin-Wide Water Temperature Model (HEC-5Q).

To provide insight into population level changes that could be expected under a variety of unimpaired flows which are being evaluated for this Bay-Delta Plan update, the State Water Board used SalSim to compare effects of unimpaired and baseline flows on fall-run Chinook salmon by evaluating potential changes in annual salmon production. Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30,* describes the SalSim results.

4.7.5 Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta

Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* prepared by Dr. Glen Hoffman, describes the scientific literature and information on subjects that impact crop productivity with saline irrigation water and analyzes the existing information from the southern

Delta and quantifies how the various factors influencing the use of saline water apply to conditions in the southern Delta.

Information from Appendix E is used to determine potential impacts on agriculture as a result of implementing the SDWQ alternatives in Chapter 11, *Agricultural Resources*.

4.7.6 Hydropower Modeling

To assess the potential impacts of the LSJR alternatives on California's electric grid, the Capacity Reduction Calculation and Power Flow Assessment was used to simulate the operation of the electric grid under peak summer demand conditions. These two technical analyses use the input of the WSE model to determine if hydropower capacity reductions and violations of California's transmission grid would occur. Appendix J, *Hydropower and Electric Grid Analysis of Lower San Joaquin River Flow Alternatives*, describes the methods and results associated with these two analyses. Information from Appendix J is used to determine potential impacts on energy and climate change from implementing the LSJR alternatives in Chapter 14, *Energy and Greenhouse Gases*.

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Chapter 5
Surface Hydrology and Water Quality

5.1 Introduction

This chapter describes the environmental setting for water supply, surface hydrology, water quality, and the regulatory framework associated with these resource areas. In this document, water supply refers to surface water diversions, and not the quantity of surface water in the watershed. This chapter also evaluates the environmental impacts, and the significance of those impacts, on surface hydrology and water quality that could result from the Lower San Joaquin River (LSJR) alternatives and southern Delta water quality (SDWQ) alternatives, and, if applicable, describes mitigation measures that would reduce or avoid any significant impacts. In addition, this chapter evaluates other potential hydrologic changes that could impact other resources, which are further evaluated in the appropriate resource chapter.

Chapter 1, *Introduction*, defines the plan area. The study area for this chapter includes all areas that may be affected by the alternatives, including: the plan area and the San Joaquin River (SJR) from Brandt Bridge through the Stockton Deepwater Ship Channel near the city of Stockton. This chapter also describes the surface hydrology and water quality of the Upper San Joaquin River (Upper SJR) (upstream of the Merced River confluence), since it flows into the LSJR, influencing flows and water quality at Vernalis. However, the Upper SJR is not considered part of the plan area for the purposes of evaluating the LSJR alternatives. Figure ES-1 depicts the SJR Basin, and Figure ES-2 depicts the plan area.

As described in Chapter 1, *Introduction*, the extended plan area generally includes the area upstream of the rim dams. The area of potential effects for this area is similar to that of the plan area and includes the zone of fluctuation around the numerous reservoirs that store water on the Stanislaus and Tuolumne Rivers (Merced does not have substantial upstream reservoirs that would be affected). It also includes the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

As shown in more detail in the impacts analysis below, the LSJR alternatives would change the three eastside tributary river flows and the LSJR flows, primarily during February–June. Changing river flows changes the water volume in the river, which can affect the concentration of constituents in the water, including pollutants and the component ions that contribute to salinity (or electrical conductivity [EC]). Changes in flows also have the potential to affect water temperatures, surface water diversions, reservoir operations, and salinity. Methods for estimating hydrologic impacts and results are presented in detail in Appendix F.1, *Hydrologic and Water Quality Modeling*, and measured data are presented in Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*.[1]

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[1] The analyses in Appendix F.1, *Hydrologic and Water Quality Modeling*, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, describe salinity (EC) using microSiemens per centimeter (µS/cm). This chapter primarily describes salinity using deciSiemens per meter (dS/m) or µS/cm. The units in the 2006 Bay-Delta Plan (mmhos/cm) are equivalent to the dS/m units used in this document; the conversion is 1 dS/m = 1000 µS/cm. EC is electrical conductivity; a widely accepted indirect method

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Board provides a preliminary determination regarding whether a proposed project would cause any potentially significant impact for each environmental category in the Checklist and provides a brief explanation for each determination. Impacts identified in Appendix B as "Potentially Significant" are discussed in are discussed in detail in this chapter. If an impact was considered to be less than significant or have no impact in Appendix B, it is not discussed any further.

Section IX of the checklist in Appendix B addresses hydrology and water quality impacts. Section IX impacts were addressed as follows.

- Impacts in Section IX(a) and (f) of Appendix B regarding water quality objectives, waste discharge requirements, or the degradation of water quality, are discussed in detail in this chapter. The potential impact that increased water temperature or other changes to water quality associated with the plan alternatives have on fisheries resources in the Lower SJR and the three eastside tributaries[2] is discussed in detail in Chapter 7, *Aquatic Biological Resources*; therefore, the discussion of water temperature in this chapter covers only a description of the baseline conditions and modeling results.
- Impacts in Section IX(c), (d), and (i) of Appendix B regarding erosion, sediment, and flooding are addressed in Chapter 6, *Flooding, Sediment, and Erosion*.
- Impacts in Section IX(b) regarding hydrologic impacts on groundwater are addressed in Chapter 9, *Groundwater Resources.*
- Impacts in Section IX(e), (g), (h), (i), and (j) were determined by the State Water Board to either be less than significant or have no impact and are briefly discussed in Appendix B.

In addition to the Section IX hydrologic impacts listed above, hydrologic changes could also impact other resources. The impacts on these resources are discussed and disclosed in Chapters 6 through 17 of this document.

Sections IX(a) and (f) of Appendix B ask if a proposed project would "[v]iolate any water quality standards or waste discharge requirements" and "[o]therwise substantially degrade water quality," respectively. The State's Water Board regulations allow the checklist (Appendix B) to be modified as appropriate to meet the particular circumstances of a project. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) The water quality analysis in this chapter emphasizes how potential changes in salinity associated with the LSJR and SDWQ alternatives affect agricultural beneficial uses. Salinity is emphasized because agricultural beneficial use is the most sensitive to salinity, salinity is the main water quality constituent likely to be affected by the plan amendments[3], salt is a constituent of great concern in the southern Delta because salinity (EC) values sometimes exceed water quality objectives, and there are sufficient EC data available to evaluate effects quantitatively. Changes to flow are also emphasized because they could increase other pollutant concentrations such that water quality objectives are exceeded. Therefore, specific impacts determined to be potentially significant include the following: (1) the LSJR flow alternatives could violate water quality objectives for salinity if they resulted in an increase in the number of months with EC above the water quality objectives for salinity

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to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

[2] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[3] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

at Vernalis or southern Delta compliance stations (i.e., Old River near Middle River, Old River at Tracy Road Bridge, and SJR at Brandt Bridge); (2) if they degrade water quality by increasing Vernalis and/or southern Delta EC such that agricultural beneficial uses are impaired; and (3) if they substantially degrade water quality due to increases in pollutant concentrations caused by reduced river flows. For water quality impacts associated with temperature refer to Chapter 7, *Aquatic Biological Resources*, and to service providers refer to Chapter 13, *Service Providers*.

The potential impacts of the LSJR on flow and SDWQ alternatives on water quality that are analyzed in this chapter are summarized in Table 5-1. The impact analysis presented in Section 5.4, *Impact Analysis*, below describes the significance thresholds for determining whether a potential impact on water quality is significant. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 5-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* Chapter 16, *Evaluation of Other Indirect and Additional Actions*, includes discussion of impacts related to actions and methods of compliance.

Table 5-1. Summary of Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact WQ-1: Violate water quality standards by increasing the number of months with EC above the water quality objectives for salinity at Vernalis or southern Delta compliance stations			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	There would be an overall reduction in monthly exceedances of EC values for the interior southern Delta compliance stations.	Less than significant	Less than significant
SDWQ Alternative 2	There would be an overall reduction of EC values above the new constant 1.0 dS/m EC objective when compared to existing EC objectives.	Less than significant	NA
SDWQ Alternative 3	There would be a reduction of EC values above the new constant 1.4 dS/m EC objective when compared to existing EC objectives such that there would no longer be any violations.	Less than significant	NA

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact WQ-2: Substantially degrade water quality by increasing Vernalis or southern Delta salinity (EC) such that agricultural beneficial uses are impaired			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	The range of average EC values during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels is expected to be reduced; accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	Less than significant	Less than significant
SDWQ Alternatives 2 and 3	These alternatives do not have the ability to result in an increase in EC because the baseline 0.7 dS/m Vernalis EC objective would continue to be maintained as part of the program of implementation. Therefore, these alternatives would not cause a change in flow or water quality. Accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	No Impact	NA
Impact WQ-3: Substantially degrade water quality by increasing pollutant concentrations caused by reduced river flows			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternatives 2, 3, and 4	Flows would generally increase, and no months with low to median flows (10th and 50th percentiles) would experience flow reductions greater than 33% of the baseline flows on the Stanislaus, Tuolumne, or Merced Rivers or the LSJR. Therefore, the change in concentrations would not substantially degrade water quality.	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
SDWQ Alternatives 2 and 3	These alternatives do not have the ability to result in an increase in pollutant concentrations because the baseline 0.7 dS/m Vernalis EC objective would continue to be maintained as part of the program of implementation. These alternatives would not cause a change in flow or water quality.	No impact	NA

1 dS/m = 1000 microSiemens per centimeter (1000 µS/cm)
dS/M = deciSiemens per meter
EC = salinity (electrical conductivity)
NA = Not applicable

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description,* and summarized in Section 5.4.2, *Methods and Approach*, of this chapter. There are no adaptive implementation or adaptive implementation methods for the SDWQ alternatives.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives established in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

5.2 Environmental Setting

This section describes the surface water hydrologic conditions (reservoir operations, stream flows, and diversions) and water quality conditions for the SJR basin as a whole, the Upper SJR, the LSJR, the three eastside tributaries, and the southern Delta. The following topics, which are important to the modeling approach and subsequent impact analysis, are included: unimpaired flows;[4] watershed infrastructure; historic river flows and the regulations and diversions that affect flow; hydropower; and water quality. Additional information about unimpaired and historical flows is in Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*.

Some additional topics are discussed for the southern Delta including the effect of Delta operations on flow and water surface elevation. The hydrology and water quality of the southern Delta is strongly influenced by the SJR inflow at Vernalis and the Central Valley Project (CVP) and the State Water Project (SWP) export pumping near Tracy.

This information is provided to establish the baseline physical conditions for comparison with the changes that are expected for the LSJR and SDWQ alternatives in Section 5.4, *Impact Analysis*.

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[4] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

5.2.1 San Joaquin River Basin and Southern Delta Hydrology and Water Quality

Following is a summary of unimpaired flow and the measured (historical) flows of the SJR Basin and southern Delta as a whole, as well as a general discussion of existing water quality conditions, including water quality impairments identified within the SJR Basin and southern Delta. Specific details of flow and water quality associated with the Upper SJR, the three eastside tributaries, the LSJR, and the southern Delta are presented in Sections 5.2.2 through 5.2.8.

Unimpaired and Historical Flow

In the Sierra Nevada, with the combination of rainfall runoff, winter snowpack accumulation, and spring snowmelt, there is a typical monthly progression of fall storm flows, winter storm flows and snowpack accumulation, spring snowmelt, and summer groundwater discharge (i.e., baseflow) (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001; Cain et al. 2003). These seasonal flow characteristics are observed in all three eastside tributaries to the SJR in nearly all years, with wide variations in runoff volume from year to year.

The hydrology of the SJR as measured at Vernalis is greatly altered from the unimpaired runoff conditions. Unimpaired flow is the river flow at a specified location that would occur if all runoff from the watershed remained in the river, without storage or diversion. Construction of many dams and agricultural diversions have altered the natural hydrology of the SJR and its major tributaries (McBain and Trush 2000; Kondolf et al. 2001; Cain et. al 2003; Brown and Bauer 2009). The unimpaired monthly hydrology is used to describe the LSJR alternatives, which reflect the year-to-year variations in monthly runoff that are observed in Central Valley hydrology and approximate flows of a more natural pattern. Therefore, it is important to describe and understand the unimpaired flows of the SJR Basin and three eastside tributary watersheds. Runoff from the SJR Basin and three eastside tributary watersheds shows wide annual, monthly (i.e., seasonal changes), and daily (i.e., storm events) variations and is modified by reservoir storage, diversions, and agricultural return flows from irrigated lands.

The SJR Basin is subject to two types of floods; prolonged rainstorms during the winter and rapid snowpack melting in the late spring and early summer of heavy snowfall years. Floods along foothill streams (without storage dams) and the LSJR often exceed channel capacities and damage urban and agricultural levees or flood portions of these areas. Floods are generally controlled below dams because the reservoir operations include sufficient flood storage space to reduce the reservoir releases to the specified maximum flood control flows, except for rare events when the spillways must be used (e.g., January 1997). Table 5-2 shows the watershed areas, median annual unimpaired runoff, and storage reservoirs for the SJR at Friant Dam and the three eastside tributaries.

Table 5-2. Watershed Characteristics for the SJR at Friant Dam and the LSJR Eastside Tributaries

Characteristic	Stanislaus River	Tuolumne River	Merced River	SJR at Friant Dam
Drainage Area of Tributary at Confluence with the SJR	1,195 square miles (980 square miles [82%] upstream of Goodwin Dam)	1,870 square miles (1,533 square miles [82%] upstream of La Grange Dam)	1,270 square miles (1,067 square miles [84%] upstream of Merced Falls)	1,660 square miles
Miles Downstream to Mouth	59 miles below Goodwin Dam	52 miles below La Grange Dam	52 miles below Crocker-Huffman Dam	NA
Average and Median Annual Unimpaired Flow (1922–2003)	1,120/1,080 TAF	1,853/1,720 TAF	960/894 TAF	1,732/1,453 TAF
Major Storage Reservoir	New Melones Dam and Reservoir (2,400 TAF)	New Don Pedro Dam and Reservoir (2,030 TAF)	New Exchequer Dam, Lake McClure (1,020 TAF)	Friant Dam, Millerton Lake (520 TAF)
Total Watershed Storage	2.85 MAF	2.94 MAF	1.04 MAF	1.15 MAF

Source: Adjusted from Cain et al. 2003.
NA = Not applicable
TAF = thousand acre-feet
MAF = million acre-feet

Water Quality and Impairments

Beneficial uses are designated for waters within a specified area by the State Water Board and each regional water board in their respective water quality control plans (WQCPs). The 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan) identifies beneficial uses within the Bay-Delta Estuary (See Section 5.3, *Regulatory Background*, for a discussion of the 2006 Bay-Delta Plan). Additionally, the Central Valley Regional Water Quality Control Board's *Fourth Edition Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan) (Central Valley Water Board 2011) identifies beneficial uses of the Delta and SJR areas within its jurisdiction. Water bodies in the plan area are used for many purposes, as evidenced by the number of beneficial uses shown in Table 5-3.

Table 5-3. Designated Beneficial Uses for Waterbodies in the Bay-Delta and the SJR Basin

Name[a]	Abbreviation[a]	Beneficial Uses[b]
Municipal and Domestic Supply	MUN	Uses of water for community, military, or individual water supply systems including drinking water supply
Agricultural Supply	AGR	Uses of water for farming, horticulture, or ranching including irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality, including mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well pressurization
Industrial Process Supply	PRO	Uses of water for industrial activities that depend primarily on water quality
Hydropower Generation	POW	Uses of water for hydropower generation
Groundwater Recharge	GWR	Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers
Navigation	NAV	Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels
Water Contact Recreation	REC-1	Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible, including swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, and use of natural hot springs
Non-Contact Water Recreation	REC-2	Uses of water for recreational activities involving proximity to water but where there is generally no body contact with water or any likelihood of ingestion of water, including picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities
Commercial and Sport Fishing	COMM	Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including uses involving organisms intended for human consumption or bait purposes
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Cold Freshwater Habitat	COLD	Uses of water that support cold water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Wildlife Habitat	WILD	Uses of water that support terrestrial or wetland ecosystems, including preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), and wildlife water and food sources

Name[a]	Abbreviation[a]	Beneficial Uses[b]
Rare, Threatened, or Endangered Species	RARE	Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant and animal species established under state or federal law as rare, threatened, or endangered
Migration of Aquatic Organisms	MIGR	Uses of water that support habitats necessary for migration and other temporary activities by aquatic organisms, such as anadromous fish
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish
Shellfish Harvesting	SHELL	Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, mussels) for human consumption, commercial, or sport purposes
Estuarine Habitat	EST	Uses of water that support estuarine ecosystems, including preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, and wildlife (e.g., estuarine mammals, waterfowl, shorebirds)

Source: Central Valley Water Board 2011; State Water Board 2006.

[a] The names, abbreviations, and beneficial use descriptions are not identical in each water quality control plan.

[b] Potential beneficial use identified in the Basin Plan.

Under Clean Water Act (CWA) Section 303(d),[5] states, territories, and authorized tribes are required to develop a ranked list of water-quality limited segments of rivers and other water bodies under their jurisdictions where effluent limitations in point-source discharge permits are not stringent enough to implement applicable water quality standards. Listed waters are those that do not meet water quality standards. The law requires that action plans, or total maximum daily loads (TMDLs), be developed to attain and maintain water quality. TMDL is defined as the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety.

State and Regional Water Boards develop lists of Section 303(d) state water bodies that do not meet applicable water quality standards (in California, beneficial uses, water quality objectives, and the state's anti-degradation policy serve as water quality standards for purposes of the CWA) and waters not expected to meet those standards with the implementation of technology-based controls. In October 2011, United States Environmental Protection Agency (USEPA) issued its final decision and gave final approval to the water bodies and pollutants added to California's Section 303(d) list. Table 5-4 shows the constituents identified in the Section 303(d) list for impaired waters in the study area plus portions of the Upper SJR.

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[5] Clean Water Act section 303(d) requires states, territories, and authorized tribes to develop a ranked list of water quality limited segments of rivers that do not meet water quality standards.

Table 5-4. Clean Water Act Section 303(d) Listed Pollutants and Sources for the Study Area and the Upper SJR

Pollutant/Stressor	Listed Source	Location of Listing
Arsenic	Source unknown	Upper SJR (Bear Creek to Mud Slough)
Benzenehexachloride (alpha-HCH)	Source unknown	LSJR (Merced River to Tuolumne River)
Boron	Agriculture	LSJR (Merced River to Tuolumne River), Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Chlorpyrifos	Agriculture, urban runoff/ storm sewers	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced River to Tuolumne River), LSJR (Tuolumne River to Stanislaus River), LSJR (Stanislaus River to Delta boundary), southern Delta, Stockton Ship Channel, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Dacthal	Agriculture	LSJR (Stanislaus River to Delta boundary), Upper SJR (Bear Creek to Mud Slough)
Dichlorodiphenyldichloroethylene (DDE)	Agriculture	LSJR (Merced River to Tuolumne River), LSJR (Stanislaus River to Delta boundary)
Dichlorodiphenyltrichloroethane (DDT)	Agriculture	LSJR (Merced River to Tuolumne River), LSJR (Tuolumne River to Stanislaus River), LSJR (Stanislaus River to Delta boundary), Southern Delta, Stockton Ship Channel, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Dissolved Oxygen (low DO)	Source unknown, organic enrichment, municipal point sources, urban runoff/ storm sewers, hydromodification	Middle River (in southern Delta), Old River (SJR to Delta-Mendota Canal), Stockton Ship Channel
Diazinon	Agriculture, urban runoff/ storm sewers	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Tuolumne River to Stanislaus River), southern Delta, Stockton Ship Channel, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Mud Slough to Merced River)
Diuron	Agriculture	LSJR (Stanislaus River to Delta boundary)
Escherichia coli (E. coli)	Source unknown	Merced River (Lower), LSJR (Stanislaus River to Delta boundary), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Group A pesticides	Agriculture	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced River to Tuolumne River), LSJR (Tuolumne River to Stanislaus River), LSJR (Stanislaus River to Delta boundary), southern Delta, Stockton Ship Channel, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)

Pollutant/Stressor	Listed Source	Location of Listing
Invasive species	Source unknown	Southern Delta, Stockton Ship Channel, Upper SJR (Friant Dam to Mendota Pool)
Mercury	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	Lake McClure, New Don Pedro Reservoir, New Melones Reservoir, Tulloch Reservoir, Woodward Reservoir, Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced River to Tuolumne River), LSJR (Tuolumne River to Stanislaus River), LSJR (Stanislaus River to Delta boundary), southern Delta, Stockton Ship Channel, Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Salinity (EC)	Agriculture	LSJR (Merced River to Tuolumne River), LSJR (Tuolumne River to Stanislaus River), LSJR (Stanislaus River to Delta boundary), southern Delta, Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Selenium	Agriculture	Upper SJR (Mud Slough to Merced River)
Temperature, water	Source unknown	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced River to Tuolumne River), LSJR (Tuolumne River to Stanislaus River), LSJR (Stanislaus River to Delta boundary)
Total dissolved solids (TDS)	Source Unknown	Old River (SJR to Delta-Mendota Canal)
Toxaphene	Source unknown	LSJR (Stanislaus River to Delta boundary)
Unknown toxicity	Source unknown, agriculture	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced River to Tuolumne River), LSJR (Tuolumne River to Stanislaus River), LSJR (Stanislaus River to Delta boundary), southern Delta, Stockton Ship Channel, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)

Source: State Water Board 2011.
Note: In addition to the pollutants listed here, the Stockton Ship Channel was on the 303 (d) list for several additional pollutants, including: dioxin, furan compounds, pathogens, and PCBs (polychlorinated biphenyls).

Section 303(d) requires that states evaluate and rank water quality impairments that cannot be resolved through point source controls and, in accordance with the priority ranking, develop a TMDL for those pollutants USEPA identifies under Section 304(a)(2) as suitable for such calculation. Table 5-5 contains a list of completed or ongoing TMDL projects in the SJR Basin and southern Delta.

Table 5-5. Summary of Completed and Ongoing Total Maximum Daily Loads in the SJR Basin and the Southern Delta

Pollutant/Stressor	Water Bodies Addressed	TMDL Status
Dissolved Oxygen	SJR-Stockton Deep Water Ship Channel (DWSC) from Stockton to Disappointment Slough	TMDL report completed—January 2005 State-Federal approval—February 2007
Chlorpyrifos and diazinon	LSJR	TMDL report completed—October 2005 State-Federal approval—December 2006
Chlorpyrifos and diazinon	SJR and Delta	TMDL report completed—June 2006 State-Federal approval—October 2007
Mercury/methylmercury	Delta	TMDL report completed—April 2010
Mercury/methylmercury	Reservoirs	Ongoing
Pesticides	Basin-wide	Ongoing
Organochlorine pesticides	SJR tributaries; Delta	Ongoing
Salt and boron	LSJR	TMDL report completed—October 2005 State-Federal approval—February 2007
Selenium	LSJR	TMDL report completed—August 2001 State-Federal approval—March 2002

Source: Central Valley Water Board 2013.
TMDL = total maximum daily load

There are numerous constituents of concern that impair water quality in the study area, as identified in Table 5-4. For example, salinity is an important parameter of concern for the southern Delta and Bay-Delta that reflects the total ionic content of the water, ranging from very low levels deemed fresh water, like those present in the plan area, to the high salinity content of seawater in SF Bay.

The SJR is unusual because salinity tends to be lower downstream (e.g., at Vernalis) than upstream of the Merced River confluence. High salinity upstream of the Merced River confluence is due to heavy contributions of salts from Salt and Mud Sloughs, as well as water re-circulated from the Delta via the Delta-Mendota Canal (DMC) and agricultural return flows. As water moves downstream, the Stanislaus, Tuolumne, and Merced Rivers dilute the salinity in the SJR because they have relatively high flows, but contribute little salt to the system. Current water quality objectives specify that SJR water entering the southern Delta at Vernalis should remain at or below 1.000 dS/m during September through March and at or below 0.700 dS/m during April through August. Because of the relatively low salinity in the three eastside tributaries, it has been possible to attain this objective by increasing releases from New Melones Reservoir on the Stanislaus River when necessary. Salinity conditions in the LSJR, Stanislaus, Tuolumne, and Merced Rivers are described in more detail below and in Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*.

A TMDL for controlling salt and boron loads to the LSJR was adopted in 2005. Implementation of the TMDL is described in the Central Valley Water Board's 2004 final staff report on amendments to the Basin Plan for the Central Valley (Central Valley Water Board 2004). The amendment recommends the implementation of a real-time water quality management program (RTMP) that would facilitate the control and timing of wetland and agricultural drainage to coincide with periods when dilution flow in the SJR is sufficient to meet Vernalis salinity objectives. The U.S. Bureau of Reclamation

(USBR) entered into an updated Management Agency Agreement with the Central Valley Water Board in 2014 that details USBR's responsibility to assist in the development and implementation of the RTMP. However, even with the TMDL load allocations, water quality objectives at Vernalis could still be exceeded. When this occurs, USBR would continue to be responsible for ensuring that the Vernalis salinity objectives are met in accordance with its water rights. Responsibility is assigned to the USBR because of the agency's large contribution to the salinity problem in the SJR basin. The water development programs of the USBR have been responsible for reducing flows in the SJR (by operating Millerton Reservoir and the Madera and Friant-Kern canals) and replacing some of that water with relatively saline water from the Delta-Mendota Canal. The main way that USBR currently fulfills its obligation to attain water quality objectives at Vernalis is by releasing relatively clean Stanislaus River water from New Melones.

Chloride, bromide, sulfate, and boron are specific ions that contribute to overall salinity and are constituents of concern; however, in the plan area, only boron is included on the 303(d) and TMDL lists. Salinity can affect multiple beneficial uses. As a habitat feature, salinity can define the types and distribution of aquatic organisms based on their adaptation to fresh water versus brackish, or saline water in the Delta. Agricultural users are also concerned with boron and salinity, since some crops are sensitive to these constituents, which can affect crop yields. Municipal water users have concerns regarding the ability to utilize recycled water when the source water has high EC values. The presence of bromide in municipal water sources is a concern since bromide is the precursor to the formation of harmful byproducts of the water disinfection process, however there are no 303(d) listing for bromide in the plan area.

As indicated above in Table 5-4, the lower portions of the Stanislaus, Tuolumne, and Merced Rivers, and the SJR to the Delta are listed as impaired due to elevated water temperatures. Water temperature conditions in the eastside tributaries and the LSJR are affected by the operation of the reservoirs and by river diversions used for agriculture. During the warmer months, water released from the three large reservoirs on the Stanislaus, Tuolumne, and Merced Rivers is relatively cool. Cool water accumulates in the reservoirs during the rainy season and during spring runoff. The cool water at the bottom of the reservoirs is minimally affected by seasonal warming that occurs at the surface during the warmer months. However, when cool water is released from the bottom of the reservoirs through the late spring, summer, and fall, the cool water supply can become depleted, potentially causing the temperature of the water that is released to the river to become warmer. While large releases may deplete cool water in reservoirs, they can also help to reduce warming along the length of a river during the warmer months. Higher flows result in faster travel times, which allow water to move farther downstream before warming to reach equilibrium with environmental conditions. Baseline water temperature conditions are described in detail in Appendix F.1, *Hydrologic and Water Quality Modeling*.

Temperature and salinity are the two main water quality parameters that may be affected by the alternatives. The plan alternatives involve changing flow in the eastside tributaries, LSJR and the southern Delta, which would affect these parameters. A discussion of the LSJR flow alternatives and the water temperature modeling results that show expected changes in water temperature is included in this chapter; however, the discussion of the potential impacts on fisheries associated with changes to water temperature can be found in Chapter 7, *Aquatic Biological Resources*.

In addition to salinity and water temperature, other water quality impairments in the SJR Watershed and southern Delta, include turbidity and suspended sediment, dissolved oxygen (DO), pesticides, herbicides, nutrients, and trace metals. The entire Delta is identified on the Section

303(d) list as impaired by unknown toxicity, which refers to the mortality of aquatic organisms and/or sublethal effects (e.g., reduced growth or reproductive success) observed during aquatic toxicity bioassays. The unknown toxicity can be caused by one or more individual toxicants that have not been identified. Poor water quality associated with the presence of pollutants can result in significant impacts on aquatic life. Trace metals, pesticides, and herbicides can be toxic to aquatic life at relatively low concentrations. Temperature and DO are of concern because the eastside tributaries, LSJR, and southern Delta serve as a migration and rearing corridor for anadromous salmonids, which are sensitive to these parameters. In the past, low DO concentrations in the Stockton Deepwater Ship Channel are thought to have negatively affected migrating adult salmonids in the fall. Excess nutrients can cause blooms of nuisance algae and aquatic vegetation, and their decay can result in low DO concentrations. Several locations in the southern Delta are listed as impaired due to low DO concentrations and a TMDL for DO was adopted in 2005 that includes measures to improve DO conditions in the Stockton Deepwater Ship Channel that include aeration facilities at the Port of Stockton.

5.2.2 Upper San Joaquin River

Unimpaired and Historical Flow

The SJR Watershed upstream of Friant Dam covers an area of about 1,660 square miles. The SJR Watershed upstream of the Merced River confluence is approximately 5,800 square miles, but most of the runoff originates upstream of Friant Dam. Several reservoirs in the upper portion of the SJR Basin, including Edison, Florence, Huntington, Mammoth Pool, and Shaver Lake, are primarily used for seasonal storage for hydroelectric power generation. These upstream reservoir operations affect inflows to Millerton Lake, the reservoir behind Friant Dam. The average annual unimpaired runoff estimated at Friant Dam is about 1,732 thousand acre-feet (TAF) and the median runoff is about 1,453 TAF. The reservoir provides a maximum storage of 520 TAF, provides flood control for the SJR, provides downstream releases to supply senior water rights diversions, and provides diversions into the Madera and Friant-Kern Canals. Flood control storage space in Millerton Lake is limited, and additional flood control is provided by the upstream reservoirs.

USBR must maintain sufficient flow between Friant Dam and Gravelly Ford to meet the needs of downstream prior water rights holders. USBR must supply a minimum flow of 5 cubic feet per second (cfs) below the last water right diversion located about 40 miles downstream of Friant Dam near Gravelly Ford. A maximum river release of about 125 cfs in the summer months supplies these downstream riparian and water right users. The maximum flood control release from Friant Dam (established by the U.S. Army Corps of Engineers (USACE) is 8,000 cfs. USBR is undertaking the SJR Restoration Program[6] which will eventually provide water throughout the year to reconnect the upstream river below Friant to the SJR at the mouth of the Merced River. In 2006, parties to *NRDC v. Rodgers* executed a stipulation of settlement that calls for, among other things, restoration of flows on the Upper SJR from Friant Dam to the confluence of the Merced River. Required release flows from Friant Dam for each water year type have been identified, but the amount of this Upper SJR water that would be observed at the mouth of the Merced River is as yet uncertain.

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[6] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future.

Hydrologic conditions are often described using cumulative distribution. The cumulative distribution of a particular variable (e.g., flow at a location) provides a basic summary of the distribution of values. The percentile (percent cumulative distribution) associated with each value indicates the percent of time that the values were less than the specified value. For example, a 10th percentile value of 2 indicates that 10 percent of the time, the values were less than 2. The 0th percentile is the minimum value, the 50th percentile is the median value, and the 100th percentile is the maximum value. In many cases, the 10th and 90th percentiles are selected to represent relatively low and relatively high values rather than the minimum and maximum because they are representative of multiple years rather than the 1 year with the highest value and the 1 year with the lowest value. A monthly year-by-year assessment is not necessary because increases in monthly values during some years may be counteracted by decreases during other years. Therefore, the evaluation of change in hydrologic parameters in this chapter and other chapters of this SED was based on the monthly cumulative distribution of values rather than individual changes in monthly values.

Table 5-6a shows the monthly cumulative distribution of SJR unimpaired runoff (cfs) at Friant Dam for 1922–2003. The range of monthly runoff is summarized with a cumulative distribution at each 10th percentile from the minimum to the maximum. The median (50 percent cumulative) monthly values provide a good summary of the seasonal pattern. The maximum runoff was in April, May, and June. The minimum runoff was in September, October, and November. The estimated median unimpaired flow pattern in the February–June period was 1,340 cfs in February, 1,925 cfs in March, 3,966 cfs in April, 6,916 cfs in May, and 5,430 cfs in June. The range of flows in these months is quite large from year to year.

Table 5-6b shows the monthly cumulative distribution of historical (observed) flow below Friant Dam (cfs) for 1985–2009 (most recent 25-year period). The highest median flows of 200 cfs are in June, July, and August. The highest historical flows (90 percent cumulative) were greater than 2,000 cfs in February–June, indicating that flood control releases were made in a few years for each of these months. The historical average annual flow volume released from Friant Dam was approximately 400 TAF, which was 25 percent of unimpaired flow. The median annual flow volume was approximately 130 TAF, indicating that the flood releases in a few years raised the average flow volume below Friant Dam to approximately three times the median flow.

Table 5-6a. Monthly Cumulative Distribution of SJR Unimpaired Flow (cfs) at Friant Dam for 1922–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	81	95	121	161	204	305	957	1,216	587	260	150	75	362
10	115	171	237	296	541	1,079	2,134	3,400	2,029	667	233	127	803
20	157	223	267	384	760	1,353	2,583	3,907	2,487	754	282	169	936
30	171	257	345	535	956	1,545	2,889	5,063	3,552	920	363	194	1,128
40	206	290	508	632	1,111	1,731	3,399	6,084	4,675	1,462	440	226	1,250
50	266	354	584	768	1,340	1,925	3,966	6,916	5,430	1,868	556	259	1,453
60	301	436	723	1,105	1,800	2,146	4,194	7,560	6,209	2,365	701	312	1,856
70	338	546	894	1,332	2,050	2,614	4,693	8,283	8,052	2,968	840	382	2,048
80	389	706	1,187	1,833	2,889	3,334	5,194	9,677	9,793	4,319	1,191	551	2,410
90	544	1,101	1,892	2,743	3,741	3,773	5,879	11,456	10,789	5,982	2,056	699	3,044
Maximum	2,048	4,151	7,489	11,953	8,506	7,895	10,300	17,826	19,597	12,225	4,558	2,853	4,642
Average	315	563	969	1,351	1,837	2,342	3,978	7,043	6,275	2,736	850	404	1,732

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-6b. Monthly Cumulative Distribution of SJR Historical Flow (cfs) below Friant Dam for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	61	56	36	32	39	36	97	121	136	150	124	114	64
10	107	73	58	39	67	88	107	126	153	172	152	132	81
20	124	96	78	58	78	92	119	144	182	198	191	157	103
30	146	107	93	85	87	109	139	158	194	209	199	173	114
40	155	118	97	94	95	119	144	165	244	219	208	183	121
50	158	120	103	96	100	137	156	181	281	232	232	189	132
60	160	125	104	100	110	174	192	218	301	260	245	219	161
70	174	133	110	111	127	422	253	262	345	281	261	237	302
80	190	147	117	118	457	1,004	1,258	1,016	637	573	278	251	766
90	215	173	164	203	2,260	2,076	4,652	4,672	2,946	739	318	292	1,305
Maximum	357	378	1,147	9,144	6,514	6,548	7,367	7,637	6,535	5,322	464	383	1,657
Average	165	129	156	468	674	802	1,172	1,172	973	659	239	209	411

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-7 shows the monthly unimpaired and historical SJR flows below Friant Dam for the most recent 10-year period of 2000–2009. The average unimpaired flow for this 10-year period was 1,687 TAF (97 percent of the 1922–2003 average). The historical flows were much less than the unimpaired flows except in wet years when flood releases were more than half of the unimpaired runoff (e.g., 2005 and 2006). Most of the runoff was seasonally stored in upstream reservoirs and in Millerton Lake and diverted to the Friant-Kern and Madera canals for irrigation. During high-flow years, however, there are considerable flood control releases from Friant Dam.

Additional flow enters the SJR from the Chowchilla and the Fresno Rivers and smaller creeks. These two rivers have smaller watersheds that do not extend to the crest of the Sierra Nevada and, consequently, have much less runoff, most of which is stored for irrigation uses. In wet years, some flood flows from the Tulare Lake Basin (i.e., Kings River) enter the SJR through Fresno Slough to the Mendota Pool. Local runoff from the Bear Creek Watershed in the vicinity of Merced and runoff with agricultural drainage and managed wetlands and wildlife refuges in the Grasslands Watershed provides additional SJR flow upstream of the Merced River. Flow and water quality in the SJR upstream of the Merced River is measured at Stevinson, upstream of Salt Slough, and at Fremont Ford, upstream of Mud Slough. Mud Slough is a combination of runoff, irrigation drainage, and discharge from the San Luis Drain that bypasses tile drainage around the Grasslands wildlife refuges and waterfowl clubs.

Water Quality

Water upstream from Friant Dam has low mineral and nutrient concentrations due to the insolubility of granitic soils in the watershed and the river's granite substrate (SCE 2007). As the SJR and tributary streams flow from the Sierra Nevada foothills across the eastern valley floor, their mineral concentration increases. Sediment is likely captured behind the many dams. Water quality in various segments of the SJR below Friant Dam is degraded because of low flow and discharges from agricultural areas and wastewater treatment plants. Water quality downstream is generally influenced by releases from Friant Dam, with contributions from agricultural and urban return flows as the river approaches the Merced River confluence. It generally becomes degraded the farther downstream it gets from the dam. Downstream of the dam, the river is identified on the 303(d) list for constituents associated with agricultural uses, such as pesticides (chlorpyrifos, diazinon, Dichlorodiphenyltrichloroethane [DDT]), salinity (EC), and unknown toxicity (State Water Board 2011) (Table 5-4).

Water temperatures below Friant Dam and Mendota Dam are dependent on water temperatures of inflow from the Delta Mendota Canal and, occasionally, the Kings River system via James Bypass. Water temperature conditions downstream are also dependent on inflow water temperatures during flood flows from upstream. SJR water temperatures south of the confluence of the Merced River are influenced greatly by the water temperature of Salt Slough inflow, which contributes the majority of streamflow in this area (USBR 2007).

5.2.3 Merced River

Unimpaired and Historical Flow

The Merced River flows into the SJR at river mile (RM) 118 and is the most upstream of the three eastside tributaries with existing fish populations. The Merced River is 135 miles long and drains a

1,270 square-mile watershed. Approximately 52 miles of the Merced River are downstream of the Crocker-Huffman Dam, the most downstream barrier to fish migration. Three of the four dams on the Merced River, known collectively as the Merced River Development Project, are owned by Merced Irrigation District (Merced ID), and Merced Falls Dam is owned by Pacific Gas and Electric Company (PG&E). Three of the dams are licensed by the Federal Energy Regulatory Commission (FERC). The Merced River unimpaired flow is essentially the same as the Lake McClure inflow because there are no major storage reservoir or diversions upstream. The runoff from the Yosemite Valley flows unimpaired downstream to Lake McClure.

Merced ID provides surface water and electric service to approximately 164,000 acres in Merced County (Merced ID 2008a). Merced ID diverts from the Merced Falls reservoir via the Northside Canal and from the Merced River via the Main Canal at the Crocker-Huffman Diversion Dam during the irrigation season. These diversions have averaged approximately 525 TAF per year (TAF/y) (Stillwater Sciences 2001).

Flows released from the Crocker-Huffman Dam to the Merced River must satisfy FERC requirements, as well as the Davis-Grunsky Contract and the Cowell Agreement requirements. Merced ID holds the FERC license (Project Number 2179) for the Merced River Hydroelectric Project, which was issued on April 18, 1964. FERC Project Number 2179 required the licensee to provide minimum stream flows (Table 5-7) in the Merced River at Shaffer Bridge, approximately 24 miles downstream from the Crocker-Huffman Dam.

Table 5-7. FERC Project Number 2179 Stream Flow Requirements for the Merced River at Shaffer Bridge (cfs)

Period	Normal Year	Dry Year
June 1–October 15	25	15
October 16–October 31	75	60
November 1–December 31	100–200	75–150
January 1–May 31	75	60

Note: On December 4, 2015, FERC released a final EIS for the relicensing of the Merced Irrigation District's and PG&E's hydroelectric projects. A new FERC license could alter the existing Merced River flow requirements.
cfs = cubic feet per second
FERC = Federal Energy Regulatory Commission

Releases from the Crocker-Huffman Dam must be greater than the FERC minimum flow requirements at Shaffer Bridge to satisfy the Cowell Agreement and the Davis-Grunsky Contract. The 1926 Cowell Agreement (pursuant to a Merced Superior Court order) calls for the Merced ID to maintain monthly flows downstream of the Crocker-Huffman Dam to satisfy water right adjudications for downstream water users. The flows are 50 cfs October–February and are 100 cfs to 250 cfs during the March–September irrigation season. This water is diverted from the river at a number of private ditches between Crocker-Huffman Dam and Shafter Bridge in accordance with the Cowell Agreement beneficiaries so that the FERC minimum flows at Shaffer Bridge are satisfied. The Davis-Grunsky Contract provides minimum flow standards of 180 cfs in dry years (less than 450,000 AF runoff) and 220 cfs in all other years from November–March at Crocker-Huffman Dam (and Shaffer Bridge) for Chinook salmon spawning and rearing. A flood control release limit of 6,000 cfs was established by USACE for the combination of Dry Creek and the Merced River flows at Stevinson.

Table 5-8a shows the monthly cumulative distribution of Merced River unimpaired runoff (flow, cfs) at New Exchequer Dam for 1922–2003. The range of monthly runoff is summarized with a cumulative distribution at each 10th percentile from the minimum to the maximum. The maximum runoff was in April, May, and June. The minimum runoff was in August, September, October, and November. The estimated median unimpaired flow pattern in the February–June period was 969 cfs in February, 1,303 cfs in March, 2,391 cfs in April, 3,955 cfs in May, and 2,451 cfs in June. The range of flows in these months is quite large from year to year.

Table 5-8b shows the monthly cumulative distribution of historical (observed) Merced River flow (cfs) at Stevinson (downstream of Dry Creek) for 1985–2009 (most recent 25-year period). The average unimpaired flow for this 25-year period was 937 TAF (98 percent of the 1922-2003 average). The highest median flows were in April and May, which are the months with highest unimpaired runoff. The highest historical Merced River flows (90 percent cumulative) were greater than 1,500 in February–June, indicating that flood control releases were made in a few years in each of these months. The monthly ranges of historical Merced River flows were large only in the months with flood control releases. The median flows in the summer months of July–September were less than 150 cfs. The historical average annual flow volume for the Merced River at Stevinson was 438 TAF, approximately 47 percent of the average unimpaired flow for this period. The median annual flow volume was 267 TAF, indicating that flood releases in a few years raised the average flow volume in the Merced River to approximately 1.5 times the median flow.

Table 5-8a. Monthly Cumulative Distributions of Merced River Unimpaired Flow at Stevinson (cfs) for 1922–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	8	20	17	54	55	131	519	637	212	62	-	-	150
10	23	59	89	162	337	601	1,352	1,650	741	129	27	-	412
20	33	86	129	214	461	851	1,562	2,179	870	191	42	4	498
30	46	102	167	326	579	970	1,927	2,832	1,400	292	63	22	566
40	63	126	256	377	801	1,102	2,155	3,295	1,923	416	83	34	669
50	81	152	354	571	969	1,303	2,391	3,955	2,451	529	121	58	894
60	96	222	448	763	1,235	1,518	2,667	4,332	2,868	721	183	79	1,070
70	116	302	560	1,069	1,821	1,875	2,880	4,730	3,462	842	221	102	1,158
80	159	372	862	1,500	2,578	2,489	3,246	5,223	4,403	1,344	273	133	1,412
90	255	699	1,647	2,579	3,514	2,718	3,643	6,400	5,633	1,991	514	203	1,718
Maximum	835	4,346	6,058	10,306	6,295	6,013	7,206	9,194	11,025	5,719	1,578	798	2,787
Average	115	335	703	1,073	1,496	1,643	2,473	3,932	2,875	909	208	93	960

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-8b. Monthly Cumulative Distribution of Historical Merced River Flow (cfs) at Stevinson for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	32	131	171	129	69	166	136	91	25	6	18	25	73
10	75	183	199	205	218	236	167	139	104	34	30	45	102
20	159	231	218	226	243	250	183	191	126	59	65	78	140
30	263	246	227	242	269	272	307	313	156	97	88	95	193
40	298	248	236	259	312	285	357	647	180	125	100	114	220
50	325	254	255	318	323	313	449	669	192	136	125	127	267
60	374	271	293	421	351	363	622	734	257	178	145	186	324
70	440	329	385	563	453	1,047	985	857	377	210	163	211	476
80	526	423	473	697	933	2,360	1,425	1,409	609	321	313	371	703
90	914	568	631	826	1,605	2,733	2,868	2,628	2,200	840	645	720	1,185
Maximum	1,861	635	2,019	7,347	6,990	2,964	4,616	4,113	3,185	2,456	722	1,127	1,275
Average	435	316	410	754	912	969	1,019	1,013	599	361	215	259	438

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-8 shows the monthly unimpaired and historical Merced River flow at Stevinson for the recent 10-year period of 2000–2009. Unimpaired flow at New Exchequer Dam averaged 884 TAF/y, and the historical releases (including flood flows in 2000, 2005 and 2006) averaged 403 TAF/y. The peak historical flows were in April and May of 2006 because Lake McClure was nearly full, and this relatively high flow of 4,500 cfs was for flood control purposes. The majority of the historical flow volume was observed in the wet years with flood control releases. Lake McClure is the smallest of the tributary reservoirs and is generally filled and drawn down each year.

Major Dams and Reservoirs

The New Exchequer powerhouse has a capacity of approximately 95 megawatts (MW) with a maximum head of 400 feet (ft) and a maximum flow of approximately 3,200 cfs (Merced ID 2008b). The hydropower facilities at the rim dams[7] operate each day to maximize energy generation efficiency and revenue, thereby giving preference to full generation during peak energy demand periods (generally 9AM–9PM). This is done by operating the turbine-generators at a constant high flow for a portion of the day and shutting them off for the remainder of the day. Water released for peaking power is regulated downstream at the approximately 10 TAF McSwain Reservoir, with a normal daily fluctuation of several feet. The McSwain Dam powerhouse has a capacity of 9 MW, with a maximum head of approximately 55 f., and a maximum flow of approximately 2,700 cfs (Merced ID 2008c). Merced Falls Dam, downstream of McSwain Dam is a small diversion dam (for MID's Northside Canal) with a small hydroelectric generator owned by Pacific Gas & Electric with a capacity of approximately 3.4 MW, a maximum head of about 50 ft., and a maximum flow of approximately 1,750 cfs (Merced ID 2008b). The Crocker-Huffman Dam, the furthest downstream

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[7] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

dam on the Merced River, diverts water to the Merced ID main canal and Merced River Hatchery and releases water to the Merced River.

Water Quality

Some water quality characteristics in the Merced River, such as water temperature, are affected by reservoir operations and by changes in river flow attributable to water supply and hydropower generation activities. Appendix F.1, *Hydrologic and Water Quality Modeling*, contains a description of baseline water temperatures on the Merced River, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, includes a presentation of existing salinity conditions.

EC generally increases as water moves downstream in the Merced River because of the relatively high EC in agricultural drainage and groundwater discharge to the river. The increase in EC is generally greater when the river flow is low due to the reduced dilution of the agriculture drainage under low flow conditions. However, near the confluence with the SJR, the measured monthly EC in the Merced River (at Stevinson) is still generally low, usually ranging from approximately 0.050 to 0.400 dS/m.

5.2.4 Tuolumne River

Unimpaired and Historical Flow

The Tuolumne River flows into the SJR at RM 83, approximately 8 miles upstream of the Stanislaus River confluence and 35 miles downstream of the Merced River. The Tuolumne River is 155 miles long and drains a 1,870 square mile watershed from its headwaters in the Sierra Nevada to its confluence with the SJR, approximately 10 miles west of Modesto. Approximately 52 miles of the river are downstream of La Grange Dam, the furthest downstream impediment to fish passage. Existing dams, water diversions, and downstream minimum flow agreements influence the hydrology of the Tuolumne River. Hetch Hetchy (360 TAF), Cherry Lake (270 TAF) and Lake Eleanor (27 TAF) in the Upper Tuolumne River Watershed provide hydropower and water supply for San Francisco and other Bay Area cities.

New Don Pedro, which is owned and operated by the Turlock Irrigation District (TID) and Modesto Irrigation District (MID), is the major storage reservoir on the Tuolumne River. The 2.0 MAF reservoir stores water for irrigation, hydroelectric generation, fish and wildlife enhancement, recreation, and flood control (340 TAF for flood control). Water released from the New Don Pedro Dam is impounded and regulated by the LaGrange Dam and Reservoir. LaGrange Dam, located 2.5 miles downstream of New Don Pedro, is the diversion point for the TID and MID canals.

TID and MID have senior water rights on the Tuolumne River and control much of the river flow in most years. Under the Raker Act, which authorized the construction of the Hetch Hetchy system, the City and County of San Francisco (CCSF) must recognize the prior rights of TID and MID to receive a certain amount of the daily natural flow of the Tuolumne River as measured at La Grange Dam when the water can be beneficially used by the districts. Under the Raker Act, CCSF must bypass 2,350 cfs, or the entire natural daily flow of the Tuolumne River whenever the flow is less than that amount. From April 15–June 13 (peak snowmelt) CCSF must bypass 4,066 cfs (FERC 1996).

The 1966 Fourth Agreement, between CCSF, TID, and MID, in part, sets forth the parties' responsibilities for water banking and operations involving New Don Pedro Reservoir, including sharing responsibility for additional instream flow requirements imposed as a result of FERC licensing. CCSF does not actually divert or store water in New Don Pedro Reservoir; instead it has a water bank account in the reservoir that provides flexibility in satisfying TID's and MID's Raker Act entitlements and its Fourth Agreement obligations. Under the Fourth Agreement, CCSF is allocated 570,000 AF of storage in Don Pedro Reservoir, with an additional 170,000 AF of storage when flood control is not required, to a maximum of 740,000 AF of storage space. Certain excess flows above the Raker Act requirements are credited to CCSF, which then "banks" the amount of water for later use. CCSF debits the water bank account when it diverts or stores water that would otherwise be within the districts' entitlements. A negative balance (CCSF bank depleted) would require prior agreement with the two irrigation districts. The Fourth Agreement also states that in the event any future changes to the New Don Pedro FERC water release conditions negatively impact the two irrigation districts, CCSF, MID, and TID would apportion the burden prorated at 51.7121 percent to CCSF and 48.2879 percent to MID and TID (CCSF/TID/MID 1966).

Figure 5-1 shows two examples of how water supplies are divided (on a daily basis) between TID and MID and CCSF under different hydrologic regimes. During a dry year in 1992, only 68 TAF (mostly in April) accrued for CCSF (68 TAF is equivalent to 1,143 cfs for 30 days). CCSF asked customers to conserve water and bought additional supplies from the California Department of Water Resources' (DWR's) emergency drought water bank due to the drought conditions that year. Rain and snow returned to the Sierra Nevada in 1993, allowing full water deliveries and replenishing surface storage in the Tuolumne River Watershed (including water banked by CCSF in New Don Pedro) and the Bay Area.

The 1922-2003 average calculated volume of water potentially available to CCSF under the Raker Act was approximately 750 TAF/y, roughly the amount CCSF can bank in New Don Pedro Reservoir under the Fourth Agreement between CCSF and MID and TID, which represents approximately 40 percent of the Tuolumne River unimpaired flow at La Grange of 1,853 TAF/y for the 1922–2003 evaluation period. According to a San Francisco Public Utilities Commission (SFPUC) planning document, an average of 244 TAF/y is diverted from the Tuolumne River at Early Intake, located below Hetch Hetchy, Cherry, and Eleanor Reservoirs, based on data from 1989-2005, which represents 32.5 percent of the average annual unimpaired flow at that location (City and County of San Francisco 2008). This CCSF diversion represents approximately 13 percent of the 1,853 TAF/y average annual unimpaired flow at La Grange.

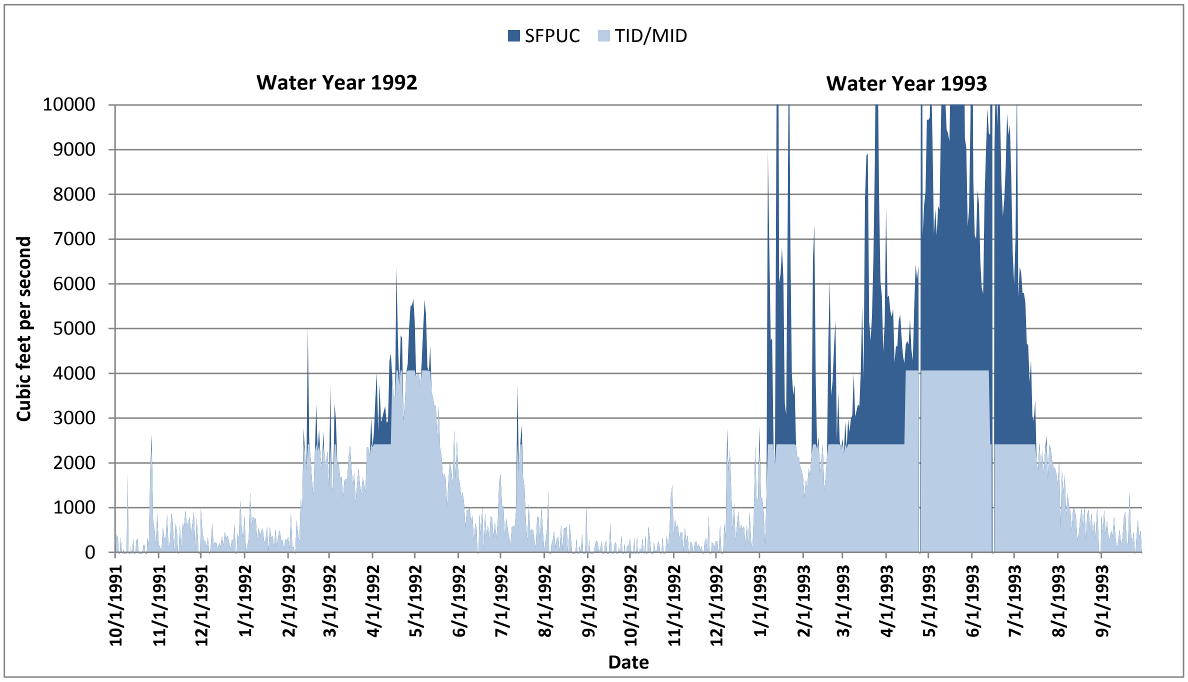

Figure 5-1. Division of Water Supply between Turlock and Modesto Irrigation Districts (TID/MID) and the City and County of San Francisco (CCSF) for 1992 and 1993 (Source: California Department of Water Resources in Environmental Defense 2004)

The average diversion into TID's canal into Turlock Lake is 575 TAF/y and another 310 TAF/y are diverted to MID's canal into the Modesto Reservoir. These diversions (885 TAF/y) represent approximately 50 percent of the median unimpaired flow of 1,776 TAF. A total of 1,175 TAF/y are diverted from the Tuolumne River, representing approximately 65 percent of the average unimpaired runoff. The FERC license (Project Number 2299) for the New Don Pedro Project was amended in 1995 to establish higher release flows on the Tuolumne River below La Grange Dam. Higher flows are required when the runoff is greater. Approximately 95 TAF are allocated on a monthly pattern in the driest years, with a maximum of approximately 300 TAF allocated in years with higher runoff. Pulse flows were specified for fish attraction to their spawning grounds in October and outmigration in April and May.

Table 5-9a gives the monthly cumulative distribution of Tuolumne River unimpaired flows for 1922–2003. Each month has a range of runoff depending on the rainfall and accumulated snowpack. The peak runoff for the Tuolumne River is observed in May and June, and relatively high runoff (median monthly runoff greater than 2,000 cfs) is observed February–June. The minimum flows are observed in August, September, and October. The median runoff for the February–June period was 2,085 cfs in February, 2,566 cfs in March, 4,498 cfs in April, 7,343 cfs in May, and 5,648 cfs in June. The average Tuolumne River runoff represents approximately 30 percent of the unimpaired flow at Vernalis. Because 290 TAF/y is diverted upstream of New Don Pedro Reservoir, the average inflow to New Don Pedro is approximately 1,563 TAF/y (85 percent of the Tuolumne River unimpaired flow).

Table 5-9b gives the monthly cumulative distribution of the historical flows for the Tuolumne River observed at Modesto for the recent period of 1985–2009. The average unimpaired flow for this 25-year period was 1,823 TAF (98 percent of the 1922–2003 average). The release flow requirements changed in 1995, as described above. The average monthly historical flows were approximately 500 cfs in the summer and fall (July–December), and were 1,000 cfs–2,000 cfs in the winter and spring (January–June). The median historical annual river flow was 361 TAF. The average annual historical flow was 811 TAF, more than 2.25 times the median, suggesting that the majority of the historical flow was the result of flood control releases in wet years. The average historical flow was approximately 45 percent of the average unimpaired flow, but the majority of this historical flow was observed in the wet years with flood control releases. New Don Pedro Reservoir allows considerable carryover storage from one year to the next.

Figure 2-9 shows the monthly unimpaired and the historical Tuolumne River flow at Modesto for the recent 10-year period of water years 2000–2009. The historical monthly flows at Modesto were generally lower than the unimpaired flows in the winter and spring months and were often slightly higher than the unimpaired flows in the late summer and fall months. The peak historical flow was in April and May of 2006 because New Don Pedro Reservoir was nearly full, and the high release flow of 8,000 cfs was for flood control purposes. The unimpaired flow at New Don Pedro Dam averaged 1,738 TAF/y and the historical releases (including flood flows in 2000, 2005, and 2006) averaged 695 TAF/y for the 10-year period. On an annual basis, the historical La Grange Dam releases averaged approximately 40 percent of the unimpaired flow, but on a daily basis the releases were usually much less than 40 percent of the unimpaired flow, with flood control releases providing the majority of the flow below LaGrange Dam.

Table 5-9a. Monthly Cumulative Distributions of Tuolumne River Unimpaired Flow (cfs) for 1922–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	0	21	55	81	142	379	1,326	1,724	283	166	0	0	383
10	64	134	219	359	752	1,354	2,719	3,467	1,509	283	52	19	842
20	87	150	332	529	1,046	1,881	3,136	4,730	2,280	364	104	42	1,055
30	116	239	423	685	1,216	2,093	3,706	5,620	3,708	559	153	63	1,189
40	149	284	550	887	1,514	2,358	4,144	6,162	4,850	919	212	85	1,414
50	178	382	783	1,213	2,085	2,566	4,498	7,343	5,648	1,119	289	125	1,776
60	193	564	920	1,715	2,496	2,870	4,927	8,071	6,722	1,781	359	165	2,024
70	254	804	1,322	2,130	2,924	3,449	5,366	8,744	7,468	2,329	447	221	2,176
80	329	1,153	1,774	2,818	4,034	4,163	5,809	9,355	8,923	3,114	563	294	2,516
90	609	1,636	3,562	4,224	5,360	5,511	6,473	10,710	10,040	4,942	901	374	3,109
Maximum	2,486	8,765	10,565	16,806	10,718	9,411	11,097	15,617	17,077	10,598	3,337	1,745	4,631
Average	265	807	1,441	2,020	2,586	3,088	4,601	7,258	5,913	2,012	432	205	1,853

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-9b. Monthly Cumulative Distribution of Historical Tuolumne River Flow (cfs) at Modesto for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	135	162	176	154	166	239	271	144	104	97	97	111	134
10	166	204	193	205	243	260	362	274	115	109	120	121	155
20	233	227	237	287	266	288	389	412	143	134	142	167	202
30	251	254	253	369	418	301	538	465	210	198	190	185	264
40	337	294	314	462	458	353	683	604	248	241	241	222	303
50	408	317	408	543	474	742	752	734	255	253	264	256	361
60	579	445	429	643	1,373	1,113	1,006	871	386	330	357	422	550
70	629	472	457	834	2,467	3,589	1,788	1,359	479	353	444	514	1,112
80	728	494	745	1,396	3,163	4,746	3,402	2,943	981	503	556	689	1,440
90	1,098	544	1,765	2,262	5,371	5,524	5,512	4,556	4,262	1,769	996	974	2,273
Maximum	1,794	1,212	4,996	15,498	8,782	6,182	8,264	7,964	5,481	3,291	1,437	2,365	2,399
Average	542	414	735	1,453	1,964	2,041	1,971	1,752	1,047	602	422	498	811

cfs = cubic feet per second
TAF = thousand acre-feet

Major Dams and Reservoirs

The hydroelectric power plant of New Don Pedro Dam has four units with a combined capacity of 203 MW and a maximum flow of 5,500 cfs (TID and MID 2011). Water released from the New Don Pedro Dam is regulated at La Grange Dam and Reservoir, which is also the diversion point for the MID and TID canals. A small hydroelectric power plant with a capacity of 4 MW and a maximum flow of 750 cfs is used to release water from the TID canal to the Tuolumne River, just downstream of La Grange Dam. Because New Don Pedro turbine capacity is generally greater than the canal diversions and river releases, it is operated for only part of each day (peaking energy); daily fluctuations in flow and water elevation in La Grange Reservoir are normal.

Water Quality

Water quality is generally considered somewhat degraded below Don Pedro Reservoir as a result of agricultural irrigation return flow and some urban and agricultural runoff (CCSF 2008). Total dissolved solids (TDS) content and turbidity generally increase in a downstream direction (CCSF 2008). The Tuolumne is identified on the 303(d) list for constituents associated with agricultural uses, such as pesticides (e.g., chlorpyrifos, diazinon, DDT), and temperature (State Water Board 2011).

Reservoir operations and changes in river flow attributable to water supply and hydropower generation activities affect some water quality characteristics in the Tuolumne River. Primary among them is water temperature. Water temperature in flowing streams depends on the temperature of the water source, air temperature, flow, surface area, and exposure to solar radiation. Reductions in stream flow when air temperature is high usually result in increases in water temperature. Storage of water in reservoirs may increase or decrease water temperatures. In the warmer months, water temperature increases in a downstream direction as the river leaves the foothills of the Sierra Nevada and flows to the floor of the San Joaquin Valley (CCSF 2008).

EC generally increases as water moves downstream in the Tuolumne River because of the relatively high EC in agricultural drainage and groundwater discharge to the river. The increase in EC is generally greater when the river flow is low. However, near the confluence with the SJR, the measured monthly EC in the Tuolumne River (at Modesto) is still generally low. The Tuolumne River EC values generally have been 0.050–0.300 dS/m (Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*).

5.2.5 Stanislaus River

Unimpaired and Historical Flow

Stanislaus River joins the SJR about 3 miles upstream of Vernalis at RM 75 and 8 miles downstream of the Tuolumne River mouth. The Stanislaus River is 161 miles long and drains approximately 1,195 square miles of mountainous and valley terrain. New Melones Reservoir, which is located just downstream of the confluence of the three forks of the Stanislaus River, is the major storage reservoir on this river. It has a storage capacity of approximately 2.4 MAF. Tulloch Dam and power plant, located 6 miles downstream of New Melones Dam, is part of the Tri-Dam Project, which is a power generation project that includes Donnells and Beardsley Dams, located upstream of New Melones Reservoir. The water released from New Melones Dam (for peaking power) is regulated in Tulloch Reservoir. Goodwin Dam is located approximately 2 miles from Tulloch Reservoir, and approximately 59 miles of the Stanislaus River are downstream of Goodwin Dam to the confluence with the LSJR.

South San Joaquin Irrigation District (SSJID), Oakdale Irrigation District (OID), Stockton East Water District (SEWD), and Central San Joaquin Water Conservation District (CSJWCD) divert water from the Stanislaus River at Goodwin Dam. SSJID and OID jointly hold rights with USBR to divert 600 TAF when the projected annual inflow to New Melones is greater than 600 TAF. OID and SSJID have an agreement to equally divide the available water, each receiving 300 TAF. USBR contracted with SEWD and CSJWCD for delivery of 155 TAF/y. The maximum diversion from the Stanislaus River is therefore 755 TAF/y. This represents approximately 67 percent of the average unimpaired Stanislaus River runoff of 1,120 TAF/y. If annual inflow to New Melones is projected to be less than 600 TAF, the OID and SSJID diversions are governed by the 1988 Agreement, which limits OID and SSJID diversions to the inflow plus one-third of the inflow deficit (600 TAF minus the inflow in TAF) (OID 2012).

The inflow to New Melones is seasonally shifted from the unimpaired flow by the upstream hydropower operations. The annual inflow to New Melones is about the same as the unimpaired runoff because, although there are several upstream storage reservoirs for hydroelectric generation, there are no major upstream diversions for consumptive uses.

Table 5-10a gives the monthly cumulative distribution of Stanislaus River unimpaired flows for 1922–2003. Each month has a range of runoff depending on the rainfall and accumulated snowpack. The peak runoff for the Stanislaus River is observed in May and June and relatively high runoff (median monthly runoff greater than 1,000 cfs) is observed February–June. The lowest median flows of approximately 150 cfs are observed in August, September, and October. The median runoff for the February–June period was 1,251 cfs in February, 1,704 cfs in March, 3,247 cfs in April, 4,657 cfs in May, and 2,757 cfs in June. The average Stanislaus River runoff represents approximately 18 percent of the average unimpaired flow at Vernalis.

Table 5-10b gives the monthly cumulative distribution of the historical flows for the Stanislaus River observed at Ripon for the recent period of 1985–2009. The average unimpaired flow for this 25-year period was 1,081 TAF (97 percent of the 1922–2003 average). The Stanislaus release flow requirements have generally increased during this period. The average monthly historical flows were approximately 500–600 cfs in the summer and fall (July–December) and were approximately 850–1,250 cfs January–June. The average annual historical flow was 584 TAF, approximately 1.5 times the median flow, suggesting that a few years had substantial flood control releases. The average historical flow was approximately 52 percent of the average unimpaired flow, but the majority of this historical flow was observed in a few wet years with flood control releases. New Melones Reservoir allows considerable carryover storage from one year to the next.

Table 5-10a. Monthly Cumulative Distributions of Stanislaus River Unimpaired Flow (cfs) for 1922–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	0	35	56	47	25	218	586	723	190	0	0	0	155
10	48	95	146	218	398	827	1,683	1,634	681	107	33	16	467
20	70	125	189	301	576	1,142	2,108	2,637	978	213	60	37	593
30	90	155	217	400	781	1,326	2,509	3,020	1,629	308	92	57	680
40	107	170	310	512	954	1,569	2,900	3,807	2,105	426	111	68	892
50	128	229	399	664	1,251	1,704	3,247	4,657	2,757	556	152	80	1,088
60	155	288	515	923	1,759	2,023	3,485	5,236	3,215	814	180	89	1,250
70	175	381	726	1,402	1,884	2,304	3,868	5,781	3,664	1,029	222	115	1,356
80	195	520	951	1,895	2,339	2,622	4,274	6,361	4,184	1,368	302	162	1,570
90	253	804	2,028	2,940	3,417	3,802	4,631	7,153	5,572	1,810	425	216	1,921
Maximum	1,438	6,155	6,704	10,724	9,250	6,742	7,271	9,675	10,627	4,659	1,246	643	2,952
Average	157	463	858	1,322	1,685	2,076	3,226	4,585	2,953	867	203	112	1,120

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-10b. Monthly Cumulative Distribution of Historical Stanislaus River Flow (cfs) at Ripon for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	251	218	179	168	183	260	251	349	218	262	215	207	191
10	323	290	222	194	220	308	507	532	464	339	305	273	309
20	339	312	262	240	297	381	595	742	578	408	327	304	330
30	391	317	304	313	312	501	742	841	591	434	356	316	344
40	434	322	316	378	349	643	813	877	609	480	368	325	384
50	479	373	341	404	435	854	902	1,091	712	502	404	369	421
60	505	392	402	458	623	1,013	976	1,302	848	560	417	416	480
70	556	414	442	614	850	1,138	1,112	1,424	1,016	654	522	458	607
80	613	428	817	1,064	1,510	2,250	1,299	1,506	1,176	743	657	490	798
90	819	627	943	1,508	2,824	2,980	1,850	1,592	1,312	1,099	1,197	978	1,172
Maximum	1,951	962	3,194	6,273	6,499	4,887	4,537	4,130	1,867	1,876	1,792	1,702	1,537
Average	579	409	559	898	1,111	1,291	1,102	1,205	843	631	559	497	584

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-10 shows the monthly unimpaired and historical Stanislaus River flow at Ripon for the recent 10-year period of water years 2000–2009. The historical (observed) monthly flows at Ripon are generally lower than the unimpaired flows in the winter and spring months and are often slightly higher than the unimpaired flows in the summer and fall months. The peak historical flows during this period were in 2006 because New Melones Reservoir was nearly full, and relatively high flows of 2,000 cfs–4,500 cfs were released for flood control purposes. The average unimpaired flow was 1,100 TAF/y and the average historical flow was 611 TAF/y for this 10-year period. The historical flow therefore averaged approximately 55 percent of the unimpaired flow on an annual basis, but the daily releases were usually less than 55 percent of the unimpaired flow, with flood control releases providing the majority of the flow below Goodwin Dam.

Major Dams and Reservoirs

New Melones reservoir has two hydroelectric generators with a combined capacity of approximately 300 MW (CEC 2012) and a maximum flow of 8,300 cfs. Tulloch Dam and power plant are located approximately 6 miles downstream of New Melones Dam. The water released from New Melones Dam (for peaking power) is regulated in Tulloch Reservoir, which has a capacity of 67 TAF (CALFED 2009). Tulloch reservoir operates with a seasonal variation in water depth and has a 3-foot daily fluctuation (from peaking hydropower releases)(Lake Tulloch Alliance 2007). The Tulloch hydroelectric plant has a capacity of 17 MW, with a maximum flow of approximately 2,000 cfs (CALFED 2009). Goodwin Dam is approximately two miles downstream of Tulloch Dam and is the diversion dam for the OID and SSJID canals. Water may also be gravity fed into the Goodwin Tunnel for deliveries to the CSJWCD and SEWD. The water supply diversions and river releases pass through Tulloch powerhouse. Because New Melones hydroelectric units are operated for only part of each day to release the daily diversions and river flow, daily fluctuations in flow and water elevations in Tulloch Reservoir are normal.

Water Quality

Some water quality characteristics in the Stanislaus River are affected by reservoir operations and by changes in river flow attributable to water supply and hydropower generation activities. Appendix F.1, *Hydrologic and Water Quality Modeling*, contains a description of baseline water temperatures on the Merced River, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, includes a presentation of measured salinity conditions.

On July 2, 1969, USBR signed a Memorandum of Agreement (MOA) with the Central Valley Water Board to provide for the scheduled releases of water from New Melones Dam for water quality purposes in order to maintain DO and TDS concentrations in the Stanislaus River and the SJR, respectively. Under this MOA, releases from New Melones Dam up to 70 TAF in any one year must be scheduled to maintain DO at or above 5 mg/L in the Stanislaus River and the TDS mean monthly concentration at a maximum of 500 mg/L in the SJR immediately below the mouth of the Stanislaus River (Central Valley Water Board 2011).

EC generally increases as water moves downstream in the Stanislaus River because of the relatively high EC in agricultural drainage and groundwater discharge to the river. The increase in EC is generally greater when the river flow is low. However, near the confluence with the SJR, the measured monthly EC in the Stanislaus River (at Ripon) is still generally low, usually ranging from approximately 0.075 to 0.150 dS/m.

5.2.6 Lower San Joaquin River

Unimpaired and Historical Flow

The drainage area of the SJR above Vernalis includes approximately 12,250 square miles. Vernalis is the measurement location for SJR inflow to the southern Delta. The flow from upstream of the Merced River together with the tributary flows from the Stanislaus, Tuolumne, and Merced Rivers, intermittent flows from the westside creeks, and agricultural drainage and groundwater seepage flows, contribute to the SJR flow at Vernalis.

The State Water Board initially established SJR at Vernalis flow objectives in the 1995 Bay-Delta Plan, which are also included in the current 2006 Bay-Delta Plan and in Revised Water Right Decision 1641 (D-1641), which is the decision that implements the water quality objectives of the 1995 Bay-Delta Plan). These flow objectives require minimum flows February 1–June 30 that depend on the SJR water year type and the Delta outflow (i.e., X2[8] requirements), which depend on the Eight River Index (the sum of unimpaired Sacramento River and SJR runoff)[9]. The 30-day April–May pulse flow requirements increase when the X2 requirement is at or west of Chipps Island (75 kilometers [km], requiring an outflow of approximately 11,400 cfs). The SJR flow objectives are given in Table 5-11. In addition, the Vernalis flow objective in October is 1,000 cfs with an additional pulse flow requirement (for attraction of adult Chinook salmon) that increases the monthly average flow to 2,000 cfs in most years.[10]

D-1641 and the 2006 Bay-Delta Plan authorized a staged implementation of the April 15–May 15 pulse flow objectives to allow for scientific experimentation by conducting the Vernalis Adaptive Management Plan (VAMP). D-1641 also established the condition for the water rights of various San Joaquin River Group Authority members to provide water for VAMP and the October pulse flow objective. As a result of the implementation of VAMP, the Vernalis flow objectives have not been fully implemented because alternative pulse flows were provided under VAMP (2000–2011), which now has ended. The VAMP flows are considered baseline and are included in the modeling described below.

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[8] X2 is the location of the 2 parts per thousand salinity contour (isohaline), 1 meter off the bottom of the estuary measured in kilometers upstream from the Golden Gate Bridge. The abundance of several estuarine species has been correlated with X2. In the 2006 Bay-Delta Plan, a salinity value--or electrical conductivity (EC) value--of 2.64 millimhos/centimeter (mmhos/cm) is used to represent the X2 location. Note, in this SED, EC is generally expressed in deciSiemens per meter (dS/m). The conversion is 1 mmhos/cm = 1 dS/cm.

[9] The *Eight River Index* is the sum of the unimpaired runoff for the Sacramento River at Bend Bridge, Feather River inflow to Oroville, Yuba River at Smartville, American River inflow to Folsom Reservoir, Stanislaus River inflow to New Melones Reservoir, Tuolumne River inflow to Don Pedro Reservoir, Merced River inflow to Lake McClure, and SJR inflow to Millerton Lake.

[10] The October flow requirement includes up to an additional 28 TAF pulse/attraction flow during all water year types. The amount of additional water will be limited to that amount necessary to provide a monthly average flow of 2,000 cfs. The additional 28 TAF is not required in a critical year following a critical year.

Table 5-11. 2006 Bay-Delta Plan Flow Requirements at Vernalis

Water Year Type	Feb–June Flows (cfs)	April–May, 30-day Pulse Flows (cfs)
Critical	710 or 1,140	3,110 or 3,540
Dry	1,420 or 2,280	4,020 or 4,880
Below Normal	1,420 or 2,280	4,620 or 5,480
Above Normal	2,130 or 3,420	5,730 or 7,020
Wet	2,130 or 3,420	7,330 or 8,620

Source: State Water Board 2006.
cfs = cubic feet per second

Table 5-12a gives the monthly cumulative distribution of the SJR at Vernalis unimpaired flows for 1922–2003. Each month has a range of runoff depending on the seasonal rainfall and accumulated snowpack. The median (50 percent) monthly flows generally characterize the seasonal runoff pattern and are largely the sum of the unimpaired runoff from the rivers draining the Sierra Nevada described above. The peak runoff for the SJR at Vernalis is observed in May, with relatively high median monthly runoff (> 15,000 cfs) observed in April, May, and June. The lowest median flows of approximately 500 cfs are observed in September and October. The median flows for the February–June period were 6,294 cfs in February, 8,227 cfs in March, 15,205 cfs in April, 23,054 cfs in May, and 16,240 cfs in June. The majority of the average SJR at Vernalis runoff originated above the four major storage dams (Friant, New Melones, New Don Pedro, and Exchequer Dams), since only approximately 500 TAF (8 percent) of the Vernalis flow was from the westside creeks and the valley floor watersheds located below the four major storage dams.

Table 5-12b gives the monthly cumulative distribution of the historical SJR flows observed at Vernalis for the recent period of 1984–2009. The average unimpaired flow for this 25-year period was 5,964 TAF (97 percent of the 1922–2003 average). The release flow requirements on the three eastside tributaries have generally increased during this period. The average monthly historical flows were approximately 2,000–2,500 cfs in the summer and fall (Jul–December) and were approximately 4,000–6,000 cfs January–June. The median historical annual SJR flow volume at Vernalis was 1,707 TAF. The average annual historical SJR at Vernalis flow volume was 2,777 TAF, approximately 1.5 times the median flow, suggesting that a few years had substantial flood control releases. The average historical SJR flow at Vernalis was approximately 46 percent of the average unimpaired flow for this 25-year period, but the majority of this historical flow was observed in a few wet years with flood control releases.

Table 5-12a. Monthly Cumulative Distributions of SJR Unimpaired Flow (cfs) at Vernalis for 1922–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	135	226	270	370	469	1,065	3,421	4,332	1,271	596	179	119	1,060
10	266	482	756	1,090	2,203	4,328	8,453	10,196	5,050	1,248	390	228	2,565
20	402	679	961	1,631	3,242	5,925	9,345	13,532	6,683	1,558	556	298	3,294
30	472	799	1,191	2,174	4,063	6,502	11,451	16,697	10,444	2,167	705	349	3,626
40	573	875	1,687	2,771	4,846	7,239	13,180	19,843	13,957	3,397	821	449	4,372
50	611	1,141	2,264	3,544	6,294	8,227	15,205	23,054	16,240	4,044	1,095	528	5,804
60	771	1,607	3,037	5,522	8,656	9,940	16,063	26,775	19,258	5,671	1,475	631	6,471
70	919	2,118	4,004	6,582	10,908	11,608	18,291	28,163	23,256	7,338	1,746	767	7,370
80	1,093	3,163	5,635	10,125	15,598	15,808	19,438	31,439	27,828	10,359	2,165	1,102	8,745
90	1,433	4,567	10,127	16,209	22,086	18,631	24,588	39,962	34,832	15,453	3,969	1,409	11,035
Maximum	6,937	25,787	35,970	61,733	41,703	42,337	43,320	57,955	63,738	34,979	11,891	5,812	18,978
Average	889	2,346	4,557	6,880	9,459	10,839	15,639	23,881	18,722	6,728	1,720	832	6,176

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-12b. Monthly Cumulative Distribution of Historical SJR Flow (cfs) at Vernalis for 1984–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	788	956	895	816	758	1,422	1,168	892	481	447	483	574	656
10	1,047	1,125	1,040	1,160	1,375	1,768	1,457	1,480	1,059	709	712	872	886
20	1,343	1,285	1,292	1,437	1,789	2,097	1,905	1,968	1,115	1,110	980	939	1,144
30	1,435	1,565	1,405	1,816	2,008	2,196	2,262	2,141	1,435	1,163	1,118	1,132	1,259
40	1,734	1,685	1,548	2,106	2,175	2,429	2,545	2,638	1,660	1,306	1,236	1,335	1,385
50	2,003	1,759	1,688	2,319	2,534	2,736	2,751	2,755	1,748	1,400	1,557	1,452	1,707
60	2,567	2,004	2,085	2,500	3,152	3,421	3,173	3,560	2,157	1,682	1,913	1,970	1,928
70	2,703	2,146	2,231	3,784	6,227	8,279	4,956	4,808	2,747	2,055	2,027	2,145	3,448
80	3,181	2,528	2,587	4,625	7,796	12,285	8,012	8,490	4,238	2,624	2,604	2,484	4,206
90	3,836	2,771	4,081	5,582	11,607	14,887	19,796	14,933	12,398	4,990	3,491	3,835	6,644
Maximum	6,153	3,290	12,192	30,377	35,057	25,035	27,937	26,055	17,760	13,193	5,442	5,758	8,588
Average	2,396	1,904	2,435	4,131	6,144	6,594	6,355	5,804	3,951	2,514	1,845	1,956	2,777

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-11 shows the monthly unimpaired historical flow at Vernalis for the recent 10-year period of water years 2000–2009. The unimpaired flows at Vernalis averaged 6,056 TAF/y and the historical releases (including flood flows in 2000, 2005, and 2006) average 2,915 TAF/y. The historical Vernalis flows average approximately 48 percent of the unimpaired flow, but the releases were usually much less than 48 percent of the unimpaired, with flood control releases providing the majority of the flow. The historical monthly flows at Vernalis were generally lower than the unimpaired flows in the winter and spring months and were often slightly higher than the unimpaired flows in the fall months.

Water Quality

Salinity and water temperature are the two main water quality constituents of concern that might be affected by the alternatives. Appendix F.1, *Hydrologic and Water Quality Modeling*, contains a description of baseline water temperatures on the LSJR, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, includes a presentation of measured salinity conditions. Both water temperature and salinity are constituents included on the 303(d) list as impairments for the LSJR (Table 5-4) (State Water Board 2011).

The EC measurements at three stations located on the LSJR between the Merced River and the Tuolumne River (Newman, Crows Landing, and Patterson) were generally similar, usually ranging from 1.000 to 1.500 dS/m but with higher values of 1.500–2.000 dS/m in the dry years of 1988–1994 and EC values of less than 0.500 dS/m during high flows of more than 5,000 cfs (Appendix F.2).

In the SJR between the Tuolumne River and the Stanislaus Rivers, EC values were measured at Maze by DWR prior to 1992 and since 2007. Values were estimated from the Vernalis flow and EC subtracting the Stanislaus flow and EC for the intermediate years. During wet years, the Maze EC measurements ranged from less than 0.250 dS/m to approximately 1.000 dS/m. In contrast, the Maze EC ranged 1.000 dS/m–2.000 dS/m in the 1988–1994 dry period, but the EC has been less than 1.250 dS/m since 2000. This EC data suggests that the SJR at Maze has a moderate salinity with EC values generally less than 1.000 dS/m, except when the flow is less than 1,000 cfs.

5.2.7 Extended Plan Area

Water quality in upstream reservoirs above populated areas in the Stanislaus and Tuolumne Watersheds is good (Kennedy-Jenks Consultants 2013). There are no substantial reservoirs upstream on the Merced River. The Stanislaus and Tuolumne Rivers both have 303(d) listings for mercury in different locations in the extended plan area and the Tuolumne River has some listings for *E.coli (*Kennedy-Jenks Consultants 2013). In addition, taste and odor complaints have been identified (but not listed on 303(d)) at Phoenix Lake reservoir on Sullivan Creek, which flows into the northern arm of Don Pedro Reservoir but not directly to the Tuolumne River (Kennedy-Jenks Consultants 2013). Much of the Upper Merced River Watershed is in Yosemite National Park and water quality is good (Kennedy-Jenks Consultants 2014). There are no 303(d) listed water bodies above Lake McClure on the Merced River (Kennedy-Jenks Consultants 2014).

5.2.8 Southern Delta

This section describes the environmental setting with regards to southern Delta flows and exports. There are four major channels in the southern Delta: the SJR from Vernalis past Stockton; Old River from the head of Old River to Clifton Court Forebay, Grant Line Canal from Old River to Clifton Court Forebay, and Middle River from Old River to Victoria Canal. Old River, between Clifton Court Forebay and Franks Tract, and Middle River downstream of Victoria Canal are also important southern Delta channels (Figure 2-12). While it mostly falls within the boundaries of the South Delta Water Agency (SDWA), the southern Delta generally includes all channels south or west of the SJR channel, some of which may be outside of SDWA boundaries.

Flows and CVP and SWP Exports

As mentioned earlier, the SJR enters the Delta at Vernalis. The Old River channel diverges from the SJR downstream of Mossdale and connects with Middle River and Grant Line Canal. The CVP and SWP intakes are located on Old River at the western end of the southern Delta. About half of the SJR flow is diverted west into Old River and about half of the SJR flow continues north toward Stockton. Water flows in the southern Delta are influenced by SJR inflow at Vernalis, channel flow splits, tidal flows, temporary barriers, water export facilities, local agricultural diversions, agricultural drainage, and municipal treated wastewater discharges.

Downstream of Vernalis, flow from the SJR splits at the head of Old River and either continues downstream in the SJR toward Stockton or enters Old River and flows toward the CVP and SWP pumps. When Vernalis flow is greater than approximately 17,500 cfs, a portion of the flow entering the southern Delta enters through Paradise Cut, about 5 miles upstream of the head of Old River. The amount of flow entering Old River (including flow through Paradise Cut) is affected by the agricultural barriers and the combined pumping rates of CVP and SWP relative to SJR inflows at Vernalis. When the combined CVP and SWP pumping rates are low, the flow split to Old River is roughly 50/50. The flow into Old River increases by approximately 5 percent of the combined CVP and SWP pumping. When the rock barrier at the head of Old River is installed for SJR fish protection, the flow into Old River is reduced to approximately 250 cfs of leakage through the rock barrier (Jones and Stokes 2001) or approximately 500 cfs if the culverts are open.

The South Delta Temporary Barriers Project was initiated by DWR in 1991 and consists of four rock barriers placed at various locations across southern Delta channels. Three of the barriers are installed to increase the channel water elevations for agricultural diversions. The head of Old River barrier has been installed in April and May of many years since 1992 (not in years with flows above 5,000 cfs) to improve juvenile Chinook salmon fish migration from the SJR. As discussed further Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives,* this barrier has been installed during the fall of most years since 1963 to improve flow and DO conditions in the downstream SJR near Stockton for the benefit of adult fall-run Chinook salmon migrating to upstream spawning locations.

The two major water diversions in the southern Delta are the SWP (Banks Pumping Plant) and the CVP (Jones Pumping Plant). The Contra Costa Water District (CCWD) also diverts water from the southern Delta. Many small agricultural diversions (siphons and pumps) divert water from throughout the Delta during the spring and summer irrigation season. The CVP Jones Pumping Plant, formerly known as Tracy Pumping Plant, is located about 5 miles northwest of Tracy. The Jones Pumping Plant consists of six pumps with a permitted diversion capacity of 4,600 cfs. The total CVP water supply contracts total approximately 3,500 TAF/y for the Jones Pumping Plant. Most of the CVP water exports come from the SJR when SJR flows at Vernalis are greater than CVP exports.

The Banks Pumping Plant has a physical pumping capacity of 10,300 cfs. However, flow diverted from the Delta into Clifton Court Forebay is limited by a USACE permit to a maximum of 6,680 cfs during much of the year. SWP water is either pumped into the South Bay aqueduct, pumped into San Luis Reservoir for seasonal storage, pumped further south in the California Aqueduct to Kern County Water agency, pumped over the Coastal Range in the Coastal Aqueduct, or pumped over the Tehachapi Pass to southern California contractors. Based on SWP contracts, the total water supply demand for the Banks Pumping plant is approximately 4,000 TAF/y.

The CVP and SWP export pumping are controlled under the 2006 Bay-Delta Plan objectives (as implemented through D-1641). Both the CVP and the SWP have maximum permitted pumping (or diversion) rates. Delta outflow requirements may limit pumping if the combined Delta inflow is not enough to satisfy the in-Delta agricultural diversions and the full capacity CVP and SWP pumping. When pumping is limited by hydrology, the Cooperative Operating Agreement (COA) governs the CVP and SWP share in reservoir releases and Delta pumping. When pumping is limited for fish protection (e.g., Old and Middle River [OMR] limits) the CVP and SWP generally share the allowable pumping.

The 1995 Bay-Delta Plan introduced the E/I ratio, which limits the combined export rate to a specified monthly fraction of the combined Delta inflow. The E/I ratio is 35 percent February–June and 65 percent June–January. The February E/I can be increased to 45 percent under low-flow conditions. This E/I objective allows a maximum pumping amount that is often similar to the allowable exports under the Delta outflow objectives, but sometimes the E/I ratio is more limiting than the required outflow. Sometimes the exports must be further reduced to increase the Delta outflow to satisfy the salinity requirements at Emmaton and Jersey Point or at the CCWD Rock Slough diversion. The SJR/export ratio was introduced as part of the 2009 National Marine Fisheries Service's Biological Opinion Stanislaus River Reasonable and Prudent Alternative (RPA), including Action 3.1.3 (NMFS BO), and limits exports to be 100 percent of the SJR inflow in critical years, 50 percent of the SJR inflow in dry years, 33 percent of the SJR inflow in below normal years, and 25 percent of the SJR inflow in above normal or wet years. These ratios effectively limit exports to 1,500 cfs for April and May unless the SJR is higher than the minimum flow required in these months (also discussed in Chapter 2, *Water Resources*). More detail about Delta regulations is provided in Appendix F.1, *Hydrologic and Water Quality Modeling.*

Tables 5-13a through 5-13c show the monthly historical CVP and SWP export pumping for 1985–2009. The CVP pumping was relatively constant through the year, with median monthly pumping of 3,500–4,200 cfs October–March. This water was used to fill the CVP portion of San Luis Reservoir to allow peak CVP water deliveries April–September. CVP pumping has been reduced April–June of most years for fish protection, with a median pumping of 2,133 cfs in April, 1,270 cfs in May, and 2,991 cfs in June. CVP pumping has been highest in July–September, with median pumping of more than 4,000 cfs. The median CVP annual pumping was approximately 2,500 TAF, which is considerably less than the total CVP demands (contracts) of 3,500 TAF. The SWP median monthly pumping was similar to the CVP pumping; the median SWP pumping was 3,000 cfs to 3,800 cfs October–March. The majority of this water was used to fill the SWP portion of San Luis Reservoir to allow peak SWP water deliveries April–September, although some water is pumped over the Tehachapi Mountains to southern California through the fall and winter months. SWP pumping has been reduced April–June of most years for fish protection, with a median pumping of 2,101 cfs in April, 1,031 cfs in May, and 1,911 cfs in June. SWP pumping has been highest in July–September with median pumping of 5,586 cfs in July, 5,539 in August, and 4,746 cfs in September. The median SWP annual pumping was approximately 2,600 TAF which is considerably less than the total SWP south-of-Delta demands (contracts) of 4,100 TAF.

The combined pumping is almost always greater than the SJR flow at Vernalis, so a considerable volume of Sacramento River water flows toward the pumps through OMR channels in almost all months. The median monthly pumping was 6,800 cfs–7,500 cfs October–March. The combined pumping was reduced for fish protection April–June, with a median pumping of 4,227 cfs in April, 2,810 cfs in May, and 4,630 cfs in June. The highest combined pumping was in the summer, with a median pumping of 9,000 cfs–10,000 cfs July–September.

Table 5-13a. Monthly Cumulative Distributions of Historical CVP Export Pumping (cfs) for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	967	954	33	1,373	557	739	816	843	790	897	989	1,594	1,338
10	2,030	2,060	1,565	2,169	2,520	1,955	1,433	857	1,096	2,914	2,677	3,333	1,932
20	3,594	2,775	2,437	2,882	3,183	2,331	1,651	936	1,725	3,838	3,911	4,001	2,079
30	3,924	3,573	3,325	3,137	3,561	2,690	1,827	1,064	2,512	4,105	4,250	4,207	2,308
40	4,117	3,705	3,591	3,490	3,710	3,378	2,022	1,179	2,912	4,241	4,347	4,272	2,475
50	4,202	3,895	3,735	3,935	3,879	3,551	2,133	1,270	2,991	4,311	4,366	4,279	2,489
60	4,236	4,098	3,864	3,985	3,936	3,903	2,164	1,390	3,025	4,340	4,375	4,289	2,501
70	4,297	4,173	4,025	4,100	4,008	4,064	2,198	1,506	3,355	4,374	4,386	4,331	2,561
80	4,310	4,218	4,129	4,202	4,196	4,105	2,357	1,736	3,980	4,395	4,399	4,361	2,627
90	4,332	4,282	4,149	4,271	4,312	4,178	2,728	2,047	4,388	4,424	4,427	4,379	2,681
Maximum	4,350	4,324	4,275	4,358	4,368	4,355	3,326	2,985	4,439	4,463	4,430	4,393	2,714
Average	3,637	3,437	3,298	3,483	3,617	3,325	2,558	1,822	2,845	4,007	3,998	3,969	2,413

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-13b. Monthly Cumulative Distributions of Historical SWP Export Pumping (cfs) for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	344	732	113	302	234	0	17	500	269	533	1,580	999	1,524
10	1,292	1,292	1,650	1,989	1,741	1,053	700	628	474	1,952	2,649	2,509	1,700
20	1,857	2,094	2,765	2,918	1,951	1,898	1,326	735	745	2,995	3,855	2,850	2,071
30	2,586	2,279	3,010	3,146	2,614	2,706	1,770	849	1,058	3,643	4,118	3,517	2,381
40	2,850	2,714	3,657	3,470	3,445	2,868	1,921	939	1,353	4,437	4,445	3,897	2,535
50	3,027	3,192	3,841	3,712	3,749	2,985	2,101	1,031	1,911	5,586	5,539	4,746	2,605
60	3,973	3,730	4,201	4,996	4,670	3,379	2,131	1,199	2,163	6,042	6,274	5,211	2,629
70	4,674	3,827	4,262	5,752	4,851	3,812	2,448	1,365	2,561	6,235	6,549	5,848	2,819
80	5,037	5,131	5,854	6,464	4,969	5,223	2,686	1,698	3,616	6,329	6,749	6,493	3,179
90	5,973	5,312	6,532	7,440	6,267	5,848	3,018	1,901	5,045	6,694	6,988	6,939	3,520
Maximum	6,455	5,834	6,838	7,801	7,391	6,888	3,868	2,617	5,965	7,162	7,147	7,149	3,688
Average	3,342	3,297	3,940	4,328	3,718	3,633	2,546	1,607	2,382	4,648	5,121	4,624	2,606

SWP = State Water Project
cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-13c. Monthly Cumulative Distributions of Historical CVP and SWP Combined Export Pumping (cfs) for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	1,732	1,687	2,088	1,674	2,263	2,062	1,464	1,377	1,760	1,431	2,569	4,140	2,945
10	4,455	3,956	3,411	4,589	4,108	3,234	2,529	1,585	1,886	4,866	5,634	5,300	3,519
20	5,226	5,192	4,789	5,901	5,571	3,903	3,269	1,748	2,545	7,018	7,538	6,984	4,364
30	5,640	5,748	6,476	6,223	6,336	5,839	3,752	2,011	3,330	7,839	8,502	7,521	4,698
40	6,371	6,213	7,197	7,120	6,771	6,950	4,137	2,527	4,252	8,914	8,839	8,177	4,976
50	7,237	6,823	7,468	7,477	7,454	7,019	4,227	2,810	4,630	9,943	9,921	9,120	5,035
60	8,127	7,671	7,875	8,918	8,450	7,052	4,390	2,982	4,951	10,335	10,657	9,568	5,179
70	8,871	8,141	8,305	9,883	8,728	7,551	4,513	3,067	6,517	10,577	10,956	10,152	5,354
80	9,254	9,325	9,577	10,495	9,143	8,015	4,758	3,287	7,367	10,713	11,161	10,816	5,887
90	10,276	9,413	10,696	11,532	10,261	8,849	5,211	3,812	9,330	10,972	11,300	11,217	6,155
Maximum	10,767	9,958	10,913	12,018	11,499	11,029	5,989	4,692	10,378	11,536	11,555	11,511	6,305
Average	6,978	6,734	7,238	7,811	7,334	6,958	5,105	3,429	5,227	8,655	9,119	8,593	5,019

CVP = Central Valley Project
SWP = State Water Project
cfs = cubic feet per second
TAF = thousand acre-feet

Southern Delta Water Levels and Flows

This section summarizes the baseline water level and flow conditions in the southern Delta channels as currently managed with the DWR Temporary Barrier Program (TBP). The temporary barriers are installed during the irrigation season in Old River near the DMC, in Grant Line Canal at Tracy Boulevard Bridge, and in Middle River upstream of Victoria Canal. The temporary barriers (weirs) block the tidal flows during ebb tide (falling water elevations, water moving downstream towards the estuary) and thereby maintain higher elevations during ebb tides. This section also summarizes modeling results that show how tidal elevations and flows in the southern Delta channels are affected by CVP and SWP pumping and by the TBP (DWR and USBR 2005). Some recent changes in the operational design of the barriers would affect these results slightly, but not materially.

Because water levels in the southern Delta channels are tidally influenced, they are always changing (fluctuating). Because agricultural diversions (siphons and pumps) may be limited at lower water levels (elevations) a general goal in the southern Delta channels has been to maintain suitable water elevations for the beneficial use of water for agriculture. Flow conditions in a tidal channel are more difficult to determine than for a river. Water elevations in a river will always increase with higher flows, whereas fluctuations in tidal elevations and tidal flows would be gradually reduced with higher net channel flows. Tidal elevations can be averaged over a monthly lunar cycle, with the average high tide (mean high water [MHW]) or the average low tide (mean low water [MLW]) calculated. Because low water levels in the southern Delta channels have the greatest effect on agricultural diversions, the MLW provides a good measure of water level conditions.

In a river, the direction of flow is downstream and flows typically dilute any salt discharge and transports the salt downstream. However, the direction and magnitude of flow for a network of tidal channels is more difficult to calculate. The tidal flow during each ebb tide moves water one direction (towards the estuary) and the tidal flow during each flood tide moves water in the opposite direction (away from the estuary). EC will increase in a tidal channel having a high salinity discharge both upstream and downstream; the increase in salinity will be less if the tidal flows are large (from a greater tidal mixing volume) or if the net flow is large (from greater dilution).

Effects of Pumping and Barriers on Water Levels and Flows

The natural tidal elevations and tidal flows that would occur in the southern Delta channels with a specific SJR inflow at Vernalis but without the CVP Jones and SWP Banks pumping diversions would be the highest possible water elevations, the greatest possible tidal flows, and the highest net flows in the southern Delta channels. This maximum possible combination of water levels, tidal flows, and net flows can be used to compare the changes (reductions) in water levels and flows in the southern Delta channels caused by exports or TBP conditions. This summary of the southern Delta channel tidal elevations and tidal flows is based on Section 5.2, *Delta Tidal Hydraulics*, of the *Draft South Delta Improvement Program Environmental Impact Statement/Environmental Impact Report* (SDIP EIS/EIR) (DWR and USBR 2005).

The major effect on southern Delta tidal elevations and tidal flows results from CVP and SWP pumping. The CVP Jones plant maximum pumping capacity is 4,600 cfs, and these pumps operate throughout the tidal cycle. The SWP Banks plant is operated to use off-peak energy, and the Clifton Court Forebay (CCF) gates are typically closed during the flood tide prior to the high tide each day to allow the maximum possible high tide elevations in the southern Delta channels (with CVP pumping). The CCF gates are also closed during low tide elevations if the water level in Old River is less than the CCF water elevation. CVP and SWP pumping will reduce the tidal elevations, with current maximum pumping of approximately 12,000 cfs lowering the high tide elevations by 1.5 ft. and lowering the low tide elevations by approximately 0.75 ft. The tidal flows in the channels are reduced substantially (50 percent less with full pumping). The net flows in Old River and Grant Line Canal (from the SJR diversion to Old River) are not changed substantially by pumping. Slightly more SJR water is diverted into Old River by CVP and SWP pumping (approximately 5 percent of the pumping flow). Most of the water needed to supply higher CVP and SWP pumping moves south in the Old and Middle River (OMR) channels from the central Delta; the net flows are increased, while the tidal flows are only reduced slightly in OMR channels downstream (i.e., north) of the pumping plants. The tidal elevations and tidal flows are more substantially affected by the temporary barriers, which block tidal flow.

Figure 5-2 shows the actual (measured) effects of the temporary barriers on tidal elevations at the Old River at the DMC barrier, located just upstream of the DMC intake in 2003. The measured daily minimum and maximum tidal elevations in Old River upstream and downstream of the temporary barrier near the DMC intake demonstrate the effect of the barrier (weir), which was installed with an elevation of approximately +2 ft. MSL (mean sea level). All of the tidal elevations show the typical lunar-cycle fluctuations (i.e., 14-day period). The minimum tidal elevations were between 0.0 and -1.0 ft. downstream of the barrier, and were increased to between 0.0 and +1 ft. MSL above the barrier when the barrier was installed (with culverts open) in early April. The minimum elevations were increased to between 1.0 and 2.0 ft. MSL above the barrier when the culverts were closed in early June (after the VAMP period). The minimum and maximum tidal elevations at Martinez for 2003 are shown for reference as the full tidal elevation range. The effect of the temporary barrier on minimum tidal elevations (MLW) was an increase of approximately 2 ft. above the barrier. Pumping does not appear to have any large effect on tidal elevations near the DMC. The temporary barrier affects flow in Old River upstream of the barrier, as discussed below.

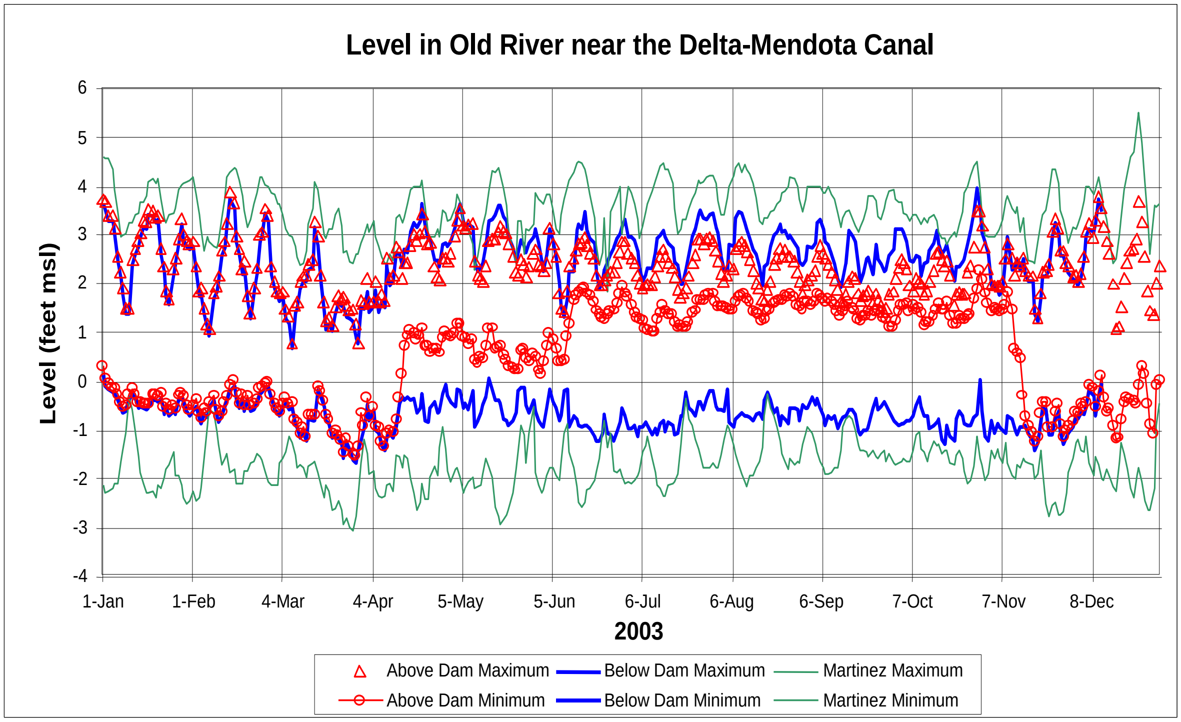

Figure 5-2. Measured Daily Minimum and Maximum Tidal Elevations in Old River Upstream and Downstream of the Temporary Barrier (near the DMC Intake) Compared to the Tidal Elevations at Martinez for 2003 (Source: DWR and USBR 2005 Figure 5.2-46) (msl = mean sea level)

A series of 1-month Delta Simulation Model II (DSM2) simulations for representative historical tidal variations of July 1985 were used in the SDIP to show the effects of CVP and SWP pumping and the effects of the temporary barriers. The simulated SJR at Vernalis flow was 1,640 cfs, the CVP pumping was 4,530 cfs, and the SWP pumping was 7,150 cfs for July 1985. The natural tidal level and flow variations in the southern Delta channels without any CVP or SWP pumping or temporary barriers were simulated as a reference. Figures 5-3a and 5-3b shows the DSM2-simulated tidal level and tidal flow volumes at the Old River at the DMC barrier location (upstream of the DMC entrance), with no CVP and no SWP pumping. The tidal flow volume was calculated from the tidal flow during each ebb or flood tide period. The daily ebb-tide or flood-tide flow volume (acre-feet [AF]) is equivalent to the average tidal flow (cfs) for the 12-hour period of flood tide (positive) or ebb tide (negative) during each day. The water level ranged from approximately –0.8 ft. to approximately 4.0 ft. MSL, with a median of 1.4 ft. MSL. The DSM2-simulated average downstream tidal flow was 1,340 cfs (during 12 hours each day), the average upstream tidal flow was –1,480 cfs (during 12 hours each day), and the net (upstream) tidal flow was –70 cfs. The simulated SJR diversion to Old River was 975 cfs, and the net flow in Grant Line Canal was 395 cfs (much less than the SJR diversion to Old River because of agricultural diversions); therefore, this upstream flow in Old River at the DMC barrier location resulted from agricultural diversions along Old River upstream of the barrier.

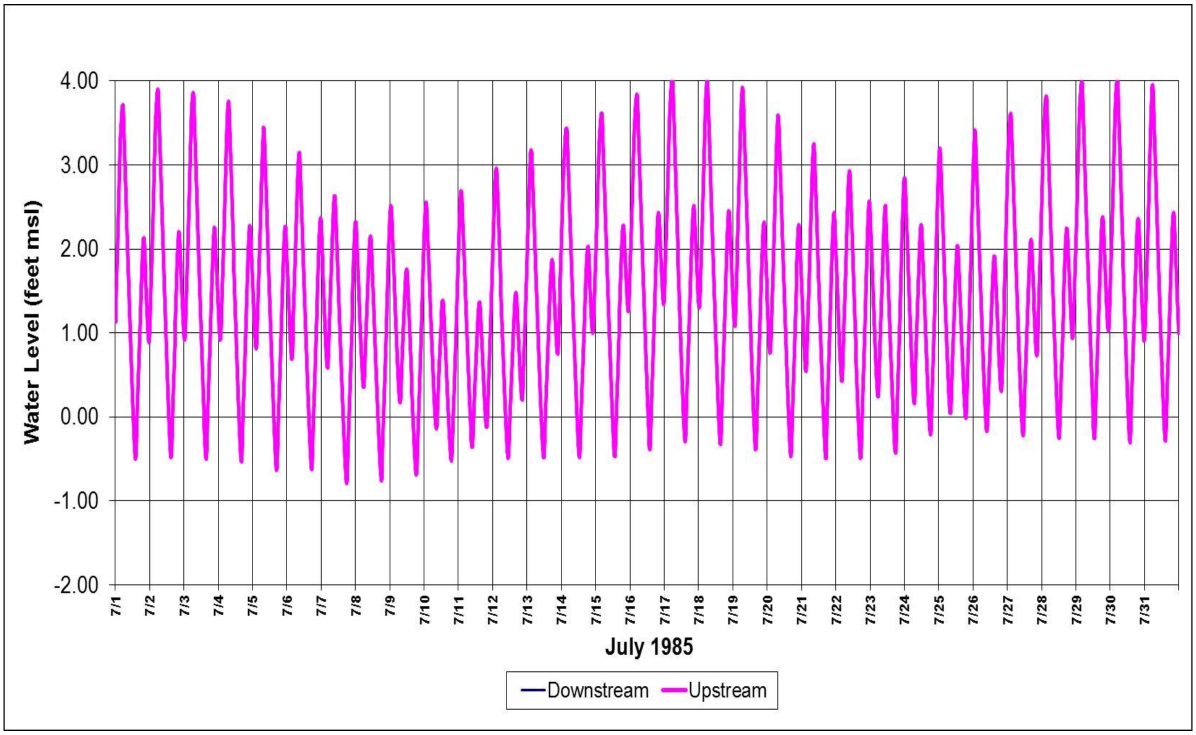

Figure 5-3a. DSM2-Simulated Tidal Elevations for Old River at the DMC Temporary Barrier Location with No CVP or SWP Pumping and No Barrier for July 1985 (Source: DWR and USBR 2005 Figure 5.2-29) (msl = mean sea level)

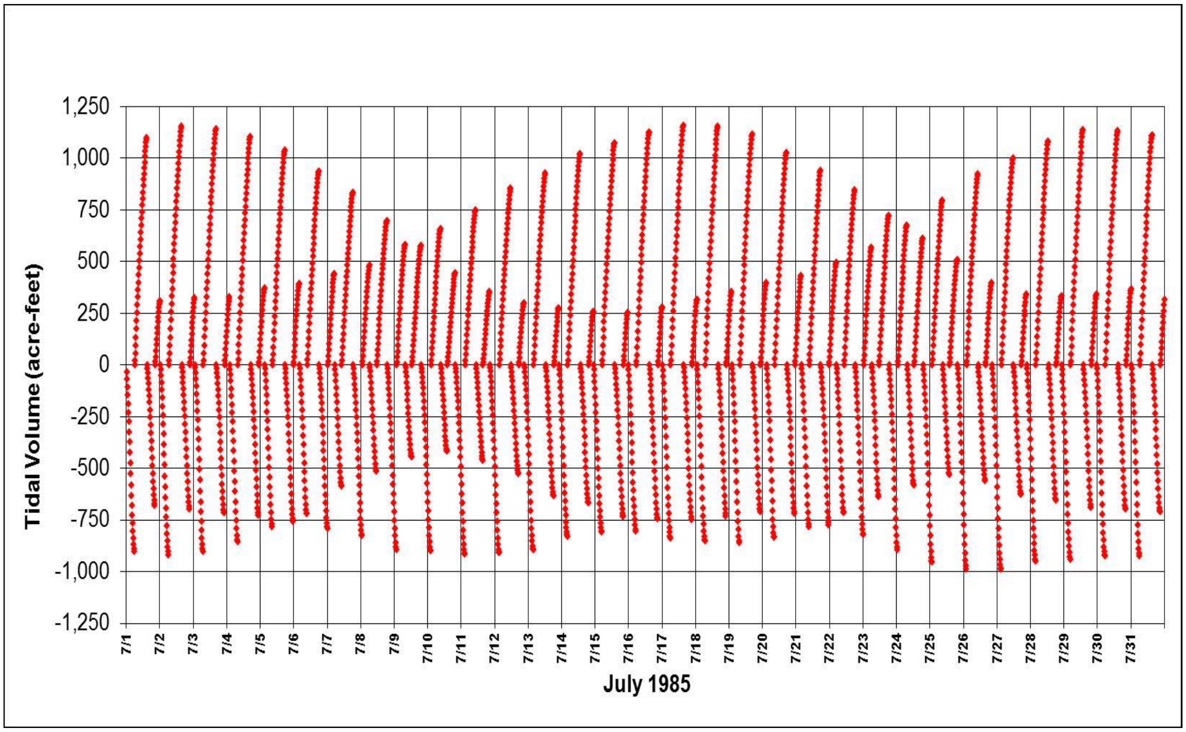

Figure 5-3b. DSM2-Simulated Tidal Flow Volumes (acre-feet) for Old River at the DMC Temporary Barrier Location with No CVP or SWP Pumping and No Barrier for July 1985 (Source: DWR and USBR 2005 Figure 5.2-29)

Figures 5-4a and 5-4b show the DSM2-simulated tidal level and tidal flow volumes at the Old River barrier location with CVP and SWP pumping (but no temporary barrier). The DSM2-simulated average downstream tidal flow was 680 cfs, and the average upstream tidal flow was −712 cfs, with a net (upstream) flow of −17 cfs. The tidal flows in Old River at the DMC barrier location were about half of the tidal flows without any CVP or SWP pumping, but the net flow was slightly increased as a result of the pumping. The simulated SJR diversion to Old River was 1,470 cfs (increased to 90 percent of the SJR flow as a result of the pumping) and the Grant Line Canal net flow was 1,017 cfs (increased because of higher SJR diversion to Old River). The CVP and SWP pumping reduced the tidal flows but increased the SJR diversion to Old River and the net flows in these southern Delta channels.

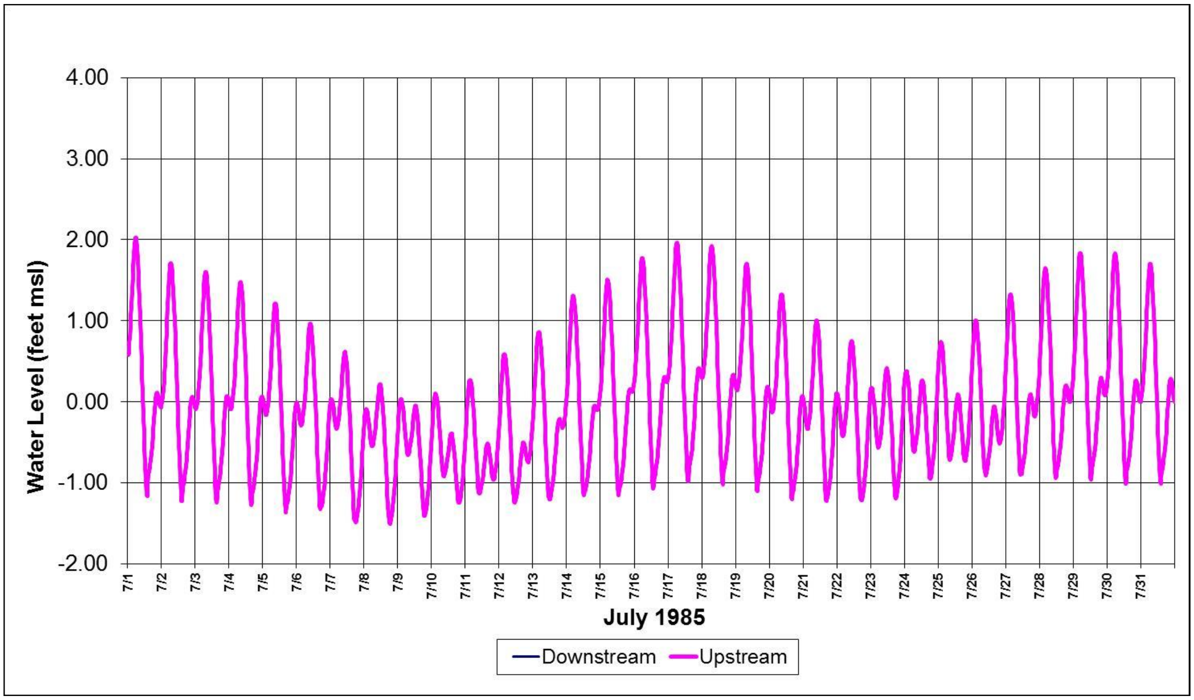

Figure 5-4a. DSM2-Simulated Tidal Elevations for Old River at the DMC Temporary Barrier Location with CVP Pumping (4,533 cfs) and SWP Pumping (7,180 cfs) with No Barriers for July 1985 (Source: DWR and USBR 2005 Figure 5.2-33) (msl = mean sea level)

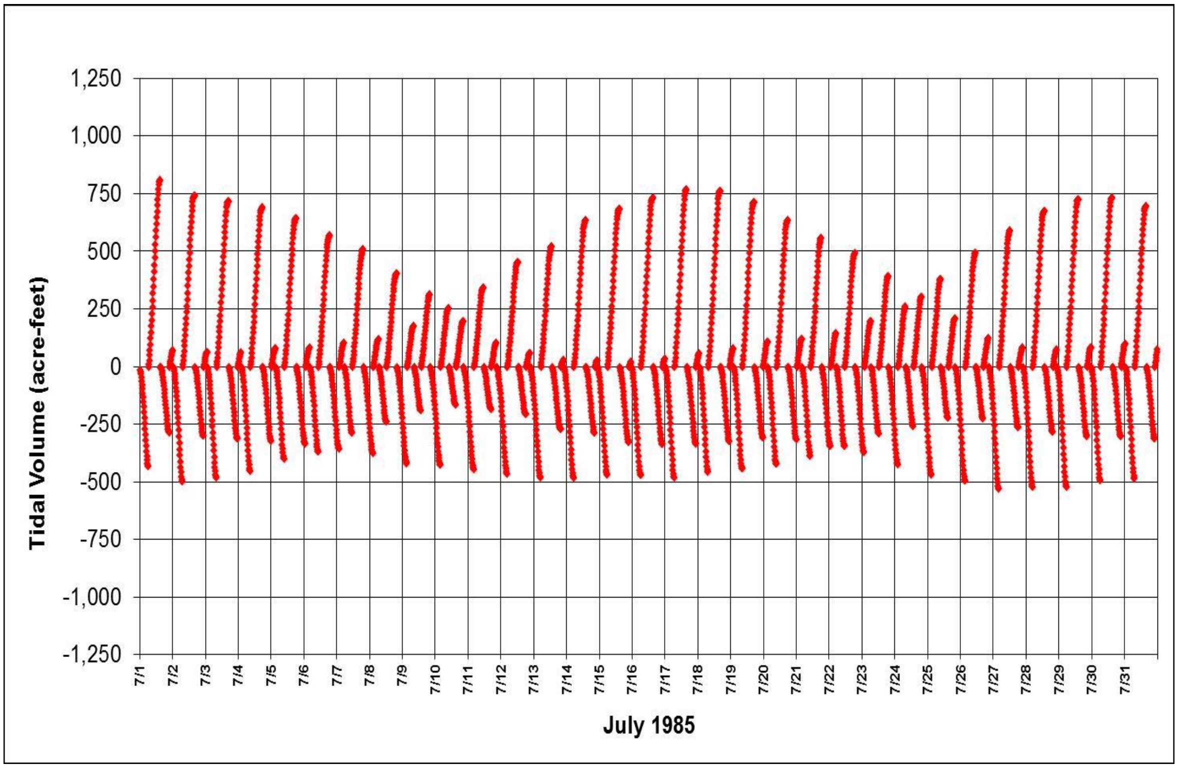

Figure 5-4b. DSM2-Simulated Tidal Flow Volumes (acre-feet) for Old River at the DMC Temporary Barrier Location with CVP and SWP Pumping with No Barriers for July 1985 (Source: DWR and USBR 2005 Figure 5.2-33)

Figures 5-5a and 5-5b show the DSM2-simulated tidal level and tidal flow volumes at the Old River temporary barrier location near the DMC with CVP and SWP pumping and with the TBP barriers. The downstream tidal level ranged from -1.8 ft. MSL to approximately 3.6 ft. MSL, with a median of 0.0 ft. MSL. The upstream water level during low tide was maintained by the temporary barrier weir, which had a simulated crest elevation of approximately 2.0 ft. The upstream tidal level varied from approximately 0.8 ft. to approximately 2.7 ft, with a median of 1.3 ft MSL. Upstream flow through the weir culverts can begin with the flood tide, although the greatest upstream flow occurs when the tidal elevation downstream of the weir rises above the weir height. The downstream tide reached a maximum of 3.5 ft MSL on many days, but the flow over the weir (of approximately 1,000 cfs) was not sustained for long and was not sufficient to raise the upstream level to more than 2.5 ft MSL. Upstream flow over the barrier did not begin until the downstream level reached the weir crest at 2.0 ft MSL. This did not occur during the neap-tide periods July 7–July 11 and again July 23–July 25. Downstream flow was blocked once the upstream level dropped to 2.0 ft MSL. The tidal flow at the Old River at DMC barrier was very restricted compared to conditions without the temporary barrier. The DSM2-simulated average downstream tidal flow was 24 cfs, and the average upstream tidal flow was -171 cfs, with a net (upstream) flow of -73 cfs. The upstream tidal flows in Old River at the DMC barrier location were approximately 25 percent of the tidal flows with CVP and SWP pumping but without the temporary barriers, but the net flow was about the same as without pumping and without barriers. The simulated SJR diversion to Old River was 930 cfs (reduced compared to without the barriers) and the Grant Line Canal net flow was 460 cfs (reduced because of less SJR diversion to Old River). The TBP barriers greatly reduced the tidal flows and also reduced the DSM2-simulated SJR diversion and net flows in these southern Delta channels. Recent tidal flow measurements at the head of Old River indicate that the effects of the temporary barriers on reducing the SJR diversions are not as large as the DSM2 model indicated; the temporary barriers may not change the net flows in the southern Delta channels, but they reduce the tidal flows upstream of the temporary barriers by approximately 50 percent. The TBP does increase the low tidal levels (MLW) by approximately 1–2 ft, but the TBP may also cause increased salinity in portions of the channels upstream of the barriers, because of reduced tidal flow mixing (dilution).

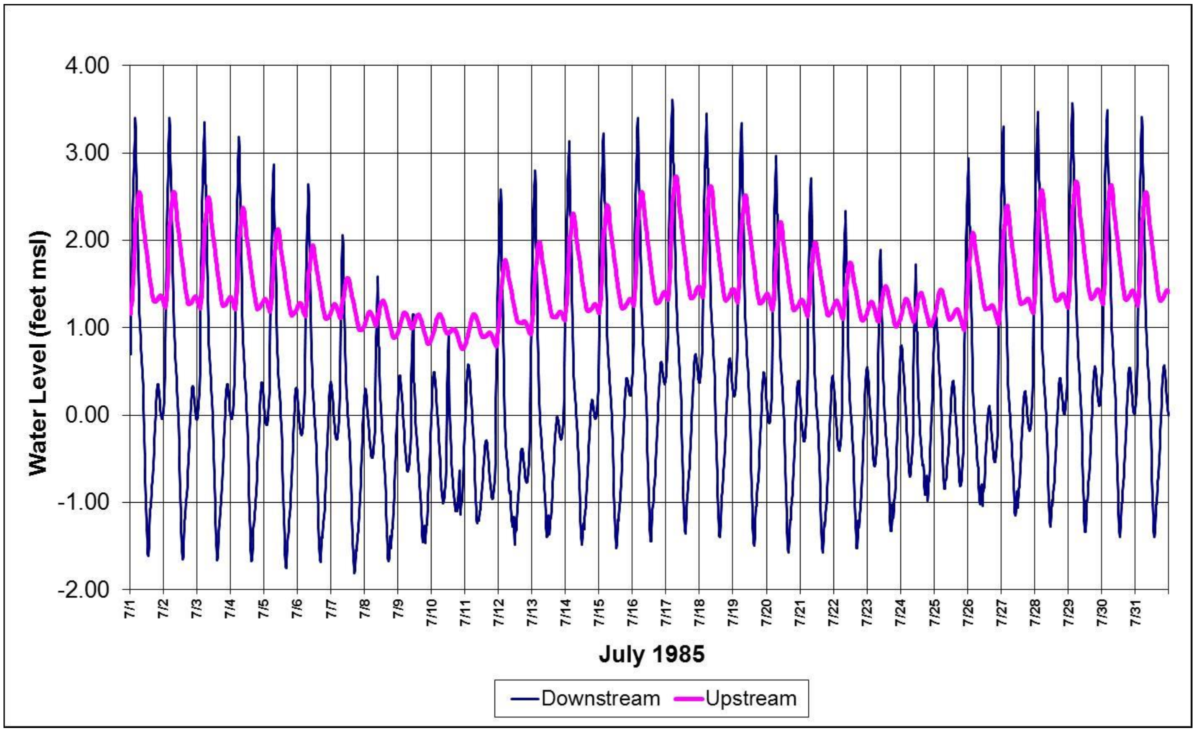

Figure 5-5a. DSM2-Simulated Tidal Elevations for Old River at the DMC Temporary Barrier with Full CVP and SWP Pumping with the Barrier Installed for July 1985 (Source: DWR and USBR 2005 Figure 5.2-37) (msl = mean sea level)

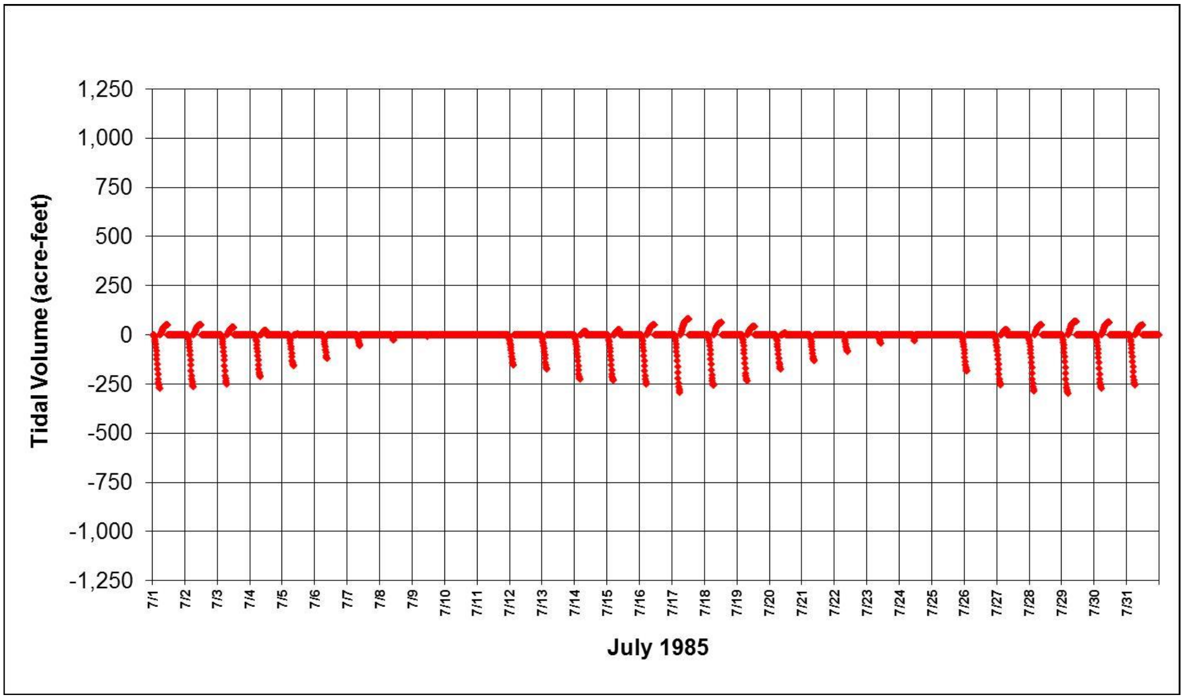

Figure 5-5b. DSM2-Simulated Tidal Flow Volumes (acre-feet) for Old River at the DMC Temporary Barrier with Full CVP and SWP Pumping with the Barrier Installed for July 1985 (Source: DWR and USBR 2005 Figure 5.2-37)

Water Quality and Salinity

The range of salinity conditions that exist across the large majority of the Delta are sufficiently low that the SJR Watershed and southern Delta channels are subject to freshwater regulatory water quality objectives. Salinity conditions in the southern Delta and SJR Watershed fall within the range of values that are adequate for freshwater aquatic life. Consequently, potential impacts on agricultural beneficial uses are the primary focus in the discussion of salinity changes in this chapter since EC values in the study area are sometimes exceed the EC objectives for the protection of agriculture beneficial uses.

A synopsis of the current Bay-Delta plan water quality objectives for the protection of agricultural water use is presented here. Further detail regarding the regulatory background with respect to water quality and other legal requirements is provided below in Section 5.3. Tables 2 and 3 of the 2006 Bay-Delta Plan include objectives for flow and EC for the southern Delta and Lower SJR to protect the beneficial uses of fish and wildlife and agriculture, respectively. The water quality objectives include the following.

> Under all water year types, the three interior southern Delta compliance stations (i.e., Old River near Middle River, Old River at Tracy Rd. Bridge, and SJR at Brandt Bridge) and the SJR at Airport Way Bridge, Vernalis station have a maximum 30-day running average of mean daily EC (dS/m) of 0.7 April–August and 1.0 September–March.[11]

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[11] Although the 0.700 dS/m salinity objective was included in the 1978 and the 1995 Bay-Delta Plans, implementation of the objective was postponed. Water Right Decision 1641 assigned responsibility to DWR and USBR to meet the 1.0/0.7 dS/m EC objective at the three southern Delta locations, and this requirement became effective on April 1, 2005. The 1.0/0.7 dS/m EC objectives at Vernalis have been implemented since 1995 when

> Under all water year types, the Stockton Deepwater Ship Channel section of the SJR between Turner Cut and the City of Stockton maintains DO levels that are above 6.0 mg/l during the months of September, October, and November for the protection migrating adult salmon.

EC values in the southern Delta are affected primarily by the salinity of water flowing into the southern Delta from the SJR at Vernalis, salt discharged back into southern Delta channels that was previously diverted for irrigation, the combined CVP and SWP pumping influencing salinity in the southern Delta, and tidal mixing of inflow from the Pacific Ocean. Municipal treated wastewater discharges have some effect on the southern Delta salinity. The SJR flow at Vernalis has a large effect on the SJR salinity at Vernalis. Higher flows will generally reduce the salinity, following a dilution relationship in which salinity is inversely proportional to the flow. Higher CVP and SWP pumping also has an effect on southern Delta salinity by bringing more low-salinity Sacramento River water across the Delta to the export pumps. However, periods of low Delta outflow (in the fall months) causes increased seawater intrusion and higher EC at the southern Delta export and CCWD intakes.

EC at the three southern Delta compliance stations downstream of Vernalis (SJR at Brandt Bridge, Old River at Middle River [Union Island], and Old River at Tracy Boulevard) are generally higher than the Vernalis EC because of agricultural drainage and municipal discharges. All of the agricultural land in the southern Delta diverts irrigation and salt leaching water (during winter months) from the southern Delta channels. The total amount of diverted water can generally be estimated from the irrigated acreage, with approximately 3–4 AF per acre applied. The withdrawal of water from channels for use on agricultural fields (i.e., agricultural diversions) does not change the salinity of the channel water. But because agricultural drainage (i.e., runoff from agricultural fields) eventually returns the diverted salt that is applied to the soils back to the channels (often during rainfall runoff and salt leaching periods in the winter), there is an indirect and/or delayed increase in southern Delta salinity. In some channel locations (e.g., Old River at Tracy Boulevard) there can be an increase in the channel salinity during the irrigation season as a result of the agricultural drainage returning to the channels (Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*).

There are several treated wastewater discharges in the southern Delta. Figure 2-12 identifies their locations. The effects of the wastewater discharges depend on the difference between the discharge EC and the river EC. All of the salt from agricultural drainage and wastewater discharges, as well as from the SJR at Vernalis, is generally exported at the CVP and SWP export pumping plants. Because CVP and SWP export pumping draws a majority of the exported water from the Sacramento River, thereby reducing the salinity in the channels near the pumping plants, it is difficult to detect the effects of agricultural drainage or treated municipal wastewater discharged in the southern Delta. Table 5-14 lists the major wastewater dischargers (greater than 1 million gallons per day) and their effect on existing EC concentrations in the southern Delta.

Water Right Order 95-6 assigned responsibility to USBR to meet the Vernalis EC objectives. D-1641 continued the requirement for USBR to meet the Vernalis EC objectives.

Table 5-14. Effect of Wastewater Dischargers on Existing Salinity Concentrations in the Southern Delta

Wastewater Discharger	Permitted Discharge (cfs)	2014 Annual Average EC (dS/m)	Daily Salt Load (Tons)	Annual Salt Load (Tons)	Effects on SJR
Manteca	27.1	0.7	33	12,140	The effect of the Manteca discharge on EC of the SJR is minimal because the average discharge EC of 0.7 dS/m is not above the irrigation season salinity objective.
Stockton	85.1	1.0	149	54,460	The effects of the Stockton discharge on EC of the SJR can be estimated for any river flow and EC value. For example, with a river flow past Stockton of 750 cfs with an EC of 0.7 dS/m (irrigation season), the Stockton discharge would increase the river EC by about 0.031 dS/m (i.e., [1.0 -0.7] x 85 / [750+85]).
Tracy	24.8	1.3	57	20,630	If the Old River flow was 750 cfs with an EC of 0.7 dS/m, the City of Tracy discharge would increase the Old River EC by about 0.019 dS/m (i.e., [1.3-0.7] x 25 / [750+25]).
Mountain House	8.4	1.0	15	5,380	The effects of the Mountain House treated wastewater discharge on EC are more difficult to estimate because the flows in this section of Old River are tidal, so water may enter and leave this Old River channel section from both ends. The net summer flows at the upstream end (near Tracy Boulevard Bridge) tend to be positive (i.e., downstream) but less than 100 cfs, because the agricultural diversions in Old River of about 100–250 cfs are drawing water from both ends of the Old River channel.
Discovery Bay	3.2	2.0	11	4,100	Because the pumping at the CVP and SWP pumps is generally greater than the Old River flow from the SJR, net flows are generally upstream and the wastewater discharge is mixed with the southern Delta exports, just like the other southern Delta discharges.

Source: Chapter 13, *Service Providers*, Tables 13-4 and 13-5.
Note: Only discharges of greater than 1 million gallons per day (1.5 cfs) are included in this table.
1 dS/m = 1000 microSiemens per centimeter (1000 µS/cm)
cfs = cubic feet per second
EC = salinity (electrical conductivity)
dS/m = deciSiemens per meter

Historical Salinity (EC) Measurements

The measured EC values throughout the southern Delta indicate that the monthly patterns of EC are generally below the existing Bay-Delta Plan EC objectives. There have been periodic exceedances of the objectives in recent dry years at one or more of these stations, but high salinity is not the general pattern. High salinity that exceeds the existing EC objectives in about half of the years in the irrigation months of April–August has been routinely measured only at Tracy Boulevard Bridge. The monthly salinity is controlled by the Vernalis EC and is then slightly increased by agricultural drainage and treated municipal wastewater. Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, describes the salinity conditions in the Lower SJR and southern Delta using the available flow, EC, and salt load data.

Baseline salinity conditions in the SJR and southern Delta channels can be summarized with the USGS and DWR monitoring data from the period 1985–2011. Tables 5-15a through 5-15d show the distribution of monthly average EC values that have been measured during that period at Vernalis, the SJR at Brandt Bridge, Old River at Middle River (Union Island), and Old River at Tracy Boulevard, respectively. The lowest values have only occasionally been below 0.200 dS/m. The highest 90th percentile value was 1.174 dS/m (in Old River at Tracy Boulevard in February). Maximum monthly values have rarely been greater than 1.200 dS/m, with the highest monthly value of 1.326 dS/m again occurring in Old River at Tracy Boulevard during February. These data show that the EC values in the southern Delta rarely fall outside of a range of 0.200–1.200 dS/m.

Table 5-15a shows the historical EC data from Vernalis for 1985–2011 (27 years), presented in the monthly cumulative distribution format. The monthly median values provide the general seasonal pattern. The highest monthly median values were in December–March, when the salinity objective in the 2006 Bay-Delta Plan is 1.000 dS/m. The lowest monthly median EC values were measured in the irrigation season of April–August, when the salinity objective in the Bay-Delta Plan is 0.700 dS/m. The average Vernalis EC was lower in months with higher flows and higher in months with lower flows. The lowest EC (10 percent cumulative values) were 0.200–0.400 dS/m during the April–August irrigation season and were 0.250–0.500 dS/m September–March.

The January and February EC values were greater than 1.000 dS/m, the current 2006 Bay-Delta Plan salinity objective, in approximately 10 percent of the years. The March and April EC values were greater than 1.000 dS/m in just a few years. The measured EC values were greater than 0.700 dS/m April–August, the current 2006 Bay-Delta Plan salinity objective, in approximately 10 percent to 30 percent of the years depending on the month (e.g., less than 10 percent for May and almost 30 percent for July). The Vernalis EC approached the 1.000 dS/m objective in January–March 2003 and January–March 2009. The Vernalis EC has been above 0.650 dS/m in only approximately 6 months during the April–August period since 1996 because New Melones releases water to meet the EC objective at Vernalis.

Table 5-15a. Monthly Average Measured SJR at Vernalis EC (µS/cm) for 1985–2011

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum	262	452	210	128	144	163	128	95	110	152	214	239
10	310	504	336	338	250	230	200	166	184	320	432	332
20	398	579	587	490	338	314	276	230	264	473	498	410
30	414	616	728	534	553	412	351	296	452	541	525	475
40	476	657	752	639	630	672	470	352	500	586	570	550
50	507	673	771	752	750	747	535	380	575	611	608	591
60	524	692	782	778	784	800	570	438	627	633	629	626
70	584	705	836	815	873	835	643	501	686	693	651	687
80	696	755	853	945	940	904	695	644	731	758	758	762
90	768	807	880	1,047	1,104	962	743	692	827	766	797	798
Maximum	866	819	926	1,137	1,299	1,095	1,144	718	871	846	873	898
Average	520	661	699	694	695	647	506	413	534	583	600	578

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-15b shows the historical EC data from Brandt Bridge for 1985–2009 (25 years), presented in the monthly cumulative distribution format. The monthly median EC values at Brandt Bridge show the same seasonal pattern as Mossdale and Vernalis. There is some agricultural drainage between Vernalis and Brandt Bridge, but the monthly EC at Brandt Bridge was similar to the EC at Vernalis and at Mossdale. The median monthly EC values were approximately 0.025–0.050 dS/m greater than the median monthly Vernalis EC values during the non-irrigation season of September–March and were 0.050–0.100 dS/m higher than the median Vernalis EC values during the irrigation season of April–August. The monthly EC values were greater than the 0.700 dS/m objective in approximately 30 percent of the years during April; in approximately 20 percent of the years during May, in approximately 40 percent of the years during June, in approximately 40 percent of the years during July, and in approximately 30 percent of the years during August. Most of the EC values greater than 0.700 dS/m were in years prior to 1995, when the salinity objective in effect at the time was 1.0 dS/m as a 30-day running average.

Table 5-15b. Monthly Average Measured SJR at Brandt Bridge EC (µS/cm) for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum	240	436	252	150	168	215	154	115	156	243	314	291
10	337	560	392	424	299	253	228	199	228	356	488	399
20	401	596	611	526	433	345	335	304	413	548	524	477
30	467	621	742	574	617	428	397	333	508	609	580	528
40	504	668	755	672	696	620	562	404	590	676	620	605
50	530	699	777	772	778	719	636	427	613	695	653	652
60	601	708	823	800	803	801	659	497	680	709	681	701
70	659	747	837	863	875	868	686	517	773	739	694	751
80	722	775	881	968	936	932	733	684	787	777	764	780
90	808	845	929	1,011	1,047	969	787	734	823	851	801	833
Maximum	941	961	955	1,063	1,213	1,108	827	840	961	888	872	959
Average	560	694	734	719	715	662	548	459	593	648	639	631

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-15c shows the monthly cumulative distribution of historical EC data from Old River at Middle River (Union Island), located just upstream of the city of Tracy discharge. The monthly median EC values were similar to Vernalis, Mossdale, and Brandt Bridge. The median EC values for 1993–2009 (17 years) were 0.588 dS/m in September, 0.510 dS/m in October, 0.711 dS/m in November, 0.818 dS/m) in December, 0.761 dS/m in January, 0.695 dS/m in February, and 0.682 dS/m in March. The monthly median EC values were 0.543 dS/m in April, 0.402 dS/m in May, 0.565 dS/m in June, 0.634 dS/m in July, and 0.630 dS/m in August. The median EC values at Union Island were sometimes greater and sometimes less than the Vernalis EC values, and were generally lower than the median EC values at Mossdale. Because the SJR water at Mossdale flows past both Brandt Bridge and Union Island, the EC values at these two stations are similar.

Table 5-15c. Monthly Average Measured Old River at Middle River (Union Island) EC (µS/cm) for 1993–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum	245	567	271	191	184	225	150	111	123	183	365	282
10	300	588	536	391	280	278	257	179	195	360	457	396
20	451	617	661	546	317	324	305	253	367	457	516	432
30	472	653	759	591	439	402	354	338	514	617	566	503
40	494	679	795	623	610	455	472	375	537	629	609	555
50	510	711	818	761	695	682	543	402	565	634	630	588
60	530	721	839	778	780	802	586	425	570	684	639	606
70	541	731	864	808	918	873	616	439	639	713	704	650
80	595	768	876	819	958	947	665	476	675	721	726	693
90	616	787	890	948	971	1,016	711	517	750	779	732	722
Maximum	660	853	907	1,008	979	1,043	855	649	899	853	918	913
Average	491	696	754	679	651	639	501	376	530	610	619	574

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-15d shows the historical EC data from Old River at Tracy Boulevard Bridge, located downstream of the City of Tracy discharge and downstream of Doughty Cut, which diverts most of the Old River flow to Grant Line Canal. This section of Old River has less tidal movement and less net flow but is influenced by several agricultural drainage pumps that discharge into Old River. The monthly median EC values for 1985–2009 (25 years) were 0.761 dS/m (170 higher than Vernalis) in September, 0.730 dS/m (223 higher than Vernalis) in October, 0.801 dS/m (128 higher) in November, 0.870 dS/m (99 higher) in December, 0.872 dS/m (120 higher) in January, 0.877 dS/m (127 higher) in February, and 0.906 dS/m (159 higher) in March. The monthly median EC values were 0.721 dS/m (186 higher) in April, 0.591 dS/m (211 higher) in May, 0.697 dS/m (122 higher) in June, 0.815 dS/m (204 higher) in July and 0.776 dS/m (168 higher) in August. These EC values are much higher than the Old River at Middle River (Union Island) EC values measured just a few miles upstream. The Tracy Boulevard Bridge location may not accurately indicate the salinity of the water being diverted from other sections of Old River for irrigation use.

Compliance with the 1995 Bay-Delta salinity objectives at Vernalis has been consistently achieved over the past 15 years (a subset of the data presented below in Table 5-15d). However, compliance with the interior southern Delta salinity objectives has not always been achieved. There is a strong relationship between salinity concentrations at Vernalis and salinity concentrations at Brandt Bridge and Old River at Middle River under most conditions. Salinity increases between Vernalis and Brandt Bridge averaged approximately 0.050 dS/m (Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives)*. The historical salinity increase for Old River at Tracy Boulevard has been greater, averaging approximately 0.150 dS/m, with several monthly increases of more than 0.200 dS/m. The monthly increases in downstream EC are greatest when the SJR flow is low because the dilution of the drainage EC or municipal discharge EC is less when the SJR flow is low.

Table 5-15d. Monthly Average Measured Old River at Tracy Boulevard Bridge EC (µS/cm) for 1985–2009

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum	294	408	355	265	286	245	194	135	240	246	325	295
10	437	630	646	399	407	339	282	266	245	461	534	512
20	554	681	714	617	493	376	411	407	463	645	644	597
30	667	716	756	727	677	467	482	433	569	703	694	626
40	674	748	831	765	782	685	672	524	625	744	737	692
50	730	801	870	872	877	906	721	591	697	815	776	761
60	779	842	901	907	904	950	825	617	786	841	812	816
70	828	858	928	1,016	1,044	968	858	709	839	904	872	871
80	875	895	994	1,096	1,094	1,059	954	748	956	931	909	934
90	1,048	978	1,054	1,167	1,174	1,114	976	778	1,034	985	980	945
Maximum	1,094	1,136	1,246	1,233	1,326	1,174	1,206	1,008	1,210	1,186	1,194	1,541
Average	726	798	848	834	827	757	684	562	692	769	771	770

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

5.3 Regulatory Background

5.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to water supply, surface hydrology, and water quality are described below.

Clean Water Act

The federal CWA (33 U.S.C., § 1251 et seq.) places primary responsibility for developing water quality standards on the states. The CWA established the basic structure for regulating point and nonpoint discharges of pollutants into the waters of the United States and gave USEPA the authority to implement pollution control programs, such as setting wastewater standards for industry. The statute employs a variety of regulatory and non-regulatory tools to reduce pollutant discharges into waters of the United States, finance municipal wastewater treatment facilities, and manage polluted runoff.

Section 303(d)

Section 303(d) of the Clean Water Act requires states to identify waters within their jurisdiction that are not attaining water quality standards and include a priority ranking of such waters. The priority ranking takes into account the severity of the pollution and the uses to be made of such waters. The State Water Board and USEPA have approved TMDLs for several pollutants and/or stressors in the plan area (Table 5-4). The 303(d) listed waters in the study area could be affected by the LSJR alternatives.

Section 401: Water Quality Certification

Under Section 401 of the Clean Water Act, applicants for a Federal license or permit to conduct activities that might result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. The FERC relicensing processes that are taking place on the Merced and Tuolumne Rivers would require issuance of water quality certifications by the State Water Board, which may include conditions to implement the flow objectives adopted in the Bay-Delta Plan update.

Federal Antidegradation Policy

The federal anti-degradation policy is designed to provide the level of water quality necessary to protect existing uses and provide protection for higher quality and outstanding national resources waters (40 CFR 131.12). Federal regulations require that state water quality standards include an anti-degradation policy consistent with the federal policy. The State Water Board has interpreted State Water Board Resolution No. 68-16 to incorporate the federal anti-degradation policy (see Chapter 23, *Antidegradation Analysis*).

HR2828 (Public Law 108-361)

H.R. No. 2828, the Water Supply, Reliability, and Environmental Improvement Act (Pub. L. No. 108-361), requires the Secretary of the Interior to develop a program to meet water quality standards and objectives for which the Central Valley Project has responsibility while reducing reliance on water releases from New Melones Reservoir made for water quality purposes. USBR is also required to develop a plan to meet its obligations for water quality and is currently initiating a process to revise the operating plan of the New Melones Reservoir. While H.R. No. 2828 affords flexibility to USBR in meeting its water quality obligations, it does not relieve USBR from its responsibility to achieve those obligations as required by its water right permits. Per the 2015 Annual Work Plan, USBR continues to operate New Melones Reservoir to ensure that the D-1641 salinity standard at Vernalis is not exceeded and no other operations or actions are identified in the work plan related to these obligations (USBR 2015). The work plan includes the development of the real-time management program that would eventually (once implemented) lead to reduced salinity at Vernalis (USBR 2015).

5.3.2 State

Relevant state programs, policies, and regulations related to water supply, surface hydrology, and water quality are described below.

The State Water Board's 2006 Bay-Delta Plan and each regional water board's basin plan identifies beneficial uses, numeric and or narrative water quality objectives for the reasonable protection of the beneficial uses, a program of implementation to achieve the objectives, together with the beneficial uses assigned to water bodies and the state anti-degradation policy. Together, the beneficial uses and the water quality objectives established to reasonably protect the beneficial uses are called water quality standards under the terminology of the federal Clean Water Act.

Porter-Cologne Water Quality Control Act of 1969

Under the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) (Wat. Code, § 13000 et seq.), the State Water Board has the authority to administer the CWA. USEPA retains oversight responsibilities. The State Water Board is updating the 2006 Bay-Delta Plan in accordance with the CWA and the Porter-Cologne Act.

Under the Porter-Cologne Act, water quality objectives are established for the purpose of protecting beneficial uses (e.g., agricultural beneficial uses or wildlife and fish beneficial uses). The Act requires the State Water Board and regional water boards to formulate and adopt WQCPs that designate the beneficial uses of the water to be protected, establish water quality objectives to reasonably protect these uses, and a program of implementation to meet the objectives.

California Water Plan

The California Water Plan is the state's strategic plan for managing and developing water resources statewide for current and future generations. DWR updates the California Water Plan every 5 years. The State Water Board considers the effect of its actions on the California Water Plan, looking toward the development, utilization, or conservation of water resources of the state. Once adopted, water quality control plans, such as the Bay-Delta Plan, become part of the California Water Plan. The California Water Plan identifies statewide resource management strategies that are grouped by different management objectives, including improving water quality and practicing resource stewardship. The Bay-Delta Plan complements the strategies and objectives identified in the California Water Plan by promoting multiple-benefit projects, such as matching water quality to beneficial uses, salt and salinity management, ecosystem restoration, and watershed management.

San Francisco Bay/Sacramento–San Joaquin Delta Estuary Water Quality Control Plan

The State Water Board's 2006 Bay-Delta Plan identifies beneficial uses of water in the Bay-Delta to be reasonably protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives. The beneficial uses designated in the Bay-Delta plan are provided in Table 5-3. For additional information on the 2006 Bay-Delta Plan, see Chapter 1, *Introduction*.

Sacramento River and San Joaquin River Basins Water Quality Control Plan

The Central Valley Water Board's Basin Plan covers the entire Sacramento and SJR Basins, including an area bounded by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west, and extending some 400 miles, from the California-Oregon border southward to the headwaters of the SJR.

The Basin Plan identifies the beneficial uses to be reasonably protected in the Sacramento and SJR Basin waterbodies, water quality objectives, implementation programs, and surveillance and monitoring programs. The Basin Plan contains specific numeric water quality objectives that are applicable to certain water bodies or portions of water bodies. Numerical objectives have been established for bacteria, DO, pH, pesticides, EC, TDS, temperature, turbidity, and trace metals. The Basin Plan also contains narrative water quality objectives for certain parameters that must be attained through pollutant control measures and watershed management. The Basin Plan includes TMDLs and the associated implementation plans adopted by the State and Regional Board and approved by USEPA pursuant to Clean Water Act Section 303(d), including those required for impairments that occur in the plan area (see Table 5-4). The State Water Board's Bay-Delta Plan supersedes the Central Valley Water Board's Basin Plan to the extent of any conflict and the Central Valley Water Board actions must conform to the Bay-Delta Plan.

State Antidegradation Policy

The goal of State Water Board Resolution No. 68-16 (Statement of Policy with Respect to Maintaining High Quality Waters in California), which applies to surface water and groundwater, is to maintain high quality waters of the State to the maximum extent possible. The State Water Board has interpreted Resolution No. 68-16 to incorporate the federal antidegradation policy (see Chapter 23, *Antidegradation Analysis*).

State Water Board Water Right Decision 1641

The Bay-Delta Plan (discussed previously) establishes water quality objectives for the Bay-Delta. State Water Board D-1641 contains the current water right requirements, applicable to DWR and USBR's operations of the SWP and CVP facilities, respectively to implement the Bay-Delta water quality objectives. D-1641 requirements pertaining to flow at Vernalis are discussed above in Section 5.2.6, *Lower San Joaquin River.*

5.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the significance of potential impacts on surface hydrology and water quality resulting from the proposed alternatives. It describes the methods used to analyze changes in the environment and to evaluate the significance of those changes. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts to less than significant accompany the impact discussion, if any significant impacts are identified. This section also summarizes results of hydrologic modeling for river flow, water supply, reservoir storage, and water temperature, under the LSJR alternatives relative to baseline to demonstrate the magnitude and timing of the effects and describe the interrelationship between flow and temperature. While these effects are summarized here, related impacts are described in other resource chapters.

5.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations. (Cal. Code Regs, tit. 23, §§ 3720–3781.) The thresholds derived from the checklist(s) have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Hydrology and water quality impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Boards Environmental Checklist*) and therefore are discussed in this analysis as to whether the alternatives could result in the following:

- Violate water quality standards by increasing the number of months with EC above the water quality objectives for salinity at Vernalis or the southern Delta compliance stations.

- Substantially degrade water quality by increasing Vernalis or southern Delta EC such that agricultural beneficial uses are impaired.
- Substantially degrade water quality by increasing pollutant concentrations caused by reduced river flows.

Where appropriate, specific quantitative or qualitative criteria are described in Section 5.4.2, *Methods and Approach* for evaluating these thresholds.

As described in Appendix B, *State Water Board's Environmental Checklist,* the LSJR and SDWQ alternatives would result in either no impact or less-than-significant impacts on the following related to surface hydrology, and water quality and, therefore, are not discussed within this chapter.

- Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff.

5.4.2 Methods and Approach

The effects of the LSJR alternatives on reservoir operations, flood control releases, water supply diversions, and water quality in the SJR at Vernalis and in the southern Delta were analyzed using the State Water Board's Water Supply Effects (WSE) model. Because flows are not expected to change in response to the SDWQ alternatives, the WSE model was not needed to assess effects of the SDWQ alternatives. The scientific basis for the WSE model is described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and the detailed methods and results for the LSJR alternatives are presented in Appendix F.1, *Hydrologic and Water Quality Modeling*.

Water Supply Effects Model

This section describes development of the WSE spreadsheet model and the assumptions used to model baseline and alternative conditions. General comparisons of the baseline and alternative results are presented in Section 5.4.3, *Hydrologic and River Temperature Modeling Results*. The initial scientific basis and methodologies for the WSE model are described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*. The methodologies, with additions and refinements to the WSE model, are summarized below. Appendix F.1, *Hydrologic and Water Quality Modeling* fully describes the development and calculation methodologies for specified unimpaired flow targets, diversions, river and reservoir water balances, and the results of the WSE model.

The WSE model is a monthly spreadsheet model that calculates monthly streamflow, reservoir storage levels, and water supply diversions for each eastside tributary based upon user-specified target flows, other user defined inputs, input from CALSIM II, flood storage rules, and an allocation of available water. The general approach is to calculate available water for diversion in each water year based on inflows, net available water from storage after carryover guidelines, and after streamflow targets are met.

The WSE model was developed because SWRCB staff determined that CALSIM II does not easily allow for the setting of monthly downstream flow targets as a fraction of unimpaired flows. Also, it is difficult to change operations and assess these changes rapidly in CALSIM. Furthermore, CALSIM and its data output are not readily understood by a wide variety of users. By utilizing a spreadsheet as the platform for the WSE model, changes in reservoir operations and the effects of changes to flow requirements can be rapidly assessed, and the model and its results are more understandable to users overall. Since the WSE model uses a similar mass balance and assumptions as CALSIM, and utilizes many of the same inputs, it produces similar results as CALSIM. The WSE model is considered a reasonably equivalent tool to CALSIM for the purposes of this analysis, and is sufficiently representative of baseline and potential alternative conditions to assess impacts. As with any model, the WSE model does not precisely re-create historic conditions, and it also does not precisely predict the potential future operations of the system. However, it can accurately depict baseline and alternative conditions such that relative comparisons can be made to analyze potential environmental impacts.

The WSE model baseline condition scenario was developed such that it would agree with CALSIM II SJR Module results when both models are subject to a similar set of assumptions and rules. The State Water Board conducted CALSIM II modeling using the CALSIM II SJR Module supplied by USBR (USBR 2013a, 2013b). This version of the model contained many of the same assumptions and inputs as the CALSIM II "Current Conditions" case used in the DWR 2009 Delivery Reliability Report (DWR 2010), a version of CALSIM II which closely represents the baseline conditions over 82 years of historic climate. The State Water Board used the USBR SJR Module, USBR Base, and made minor adjustments to operations on the Stanislaus River and Vernalis pulse flow requirements as described in Appendix F.1, *Hydrologic and Water Quality Modeling,* in order to make the CALSIM SJR Module most appropriately represent the baseline condition for this analysis. The results from this CALSIM run (SWRCB–CALSIM) can be compared to the WSE model results. Figure 5-6 contains an example of the WSE model to State Water Board-CALSIM comparison contained in Appendix F.1 for baseline regulatory conditions (the final WSE model baseline simulation contained some further modifications described in Appendix F.1, Section F.1.2.4, that resulted in divergence from CALSIM).

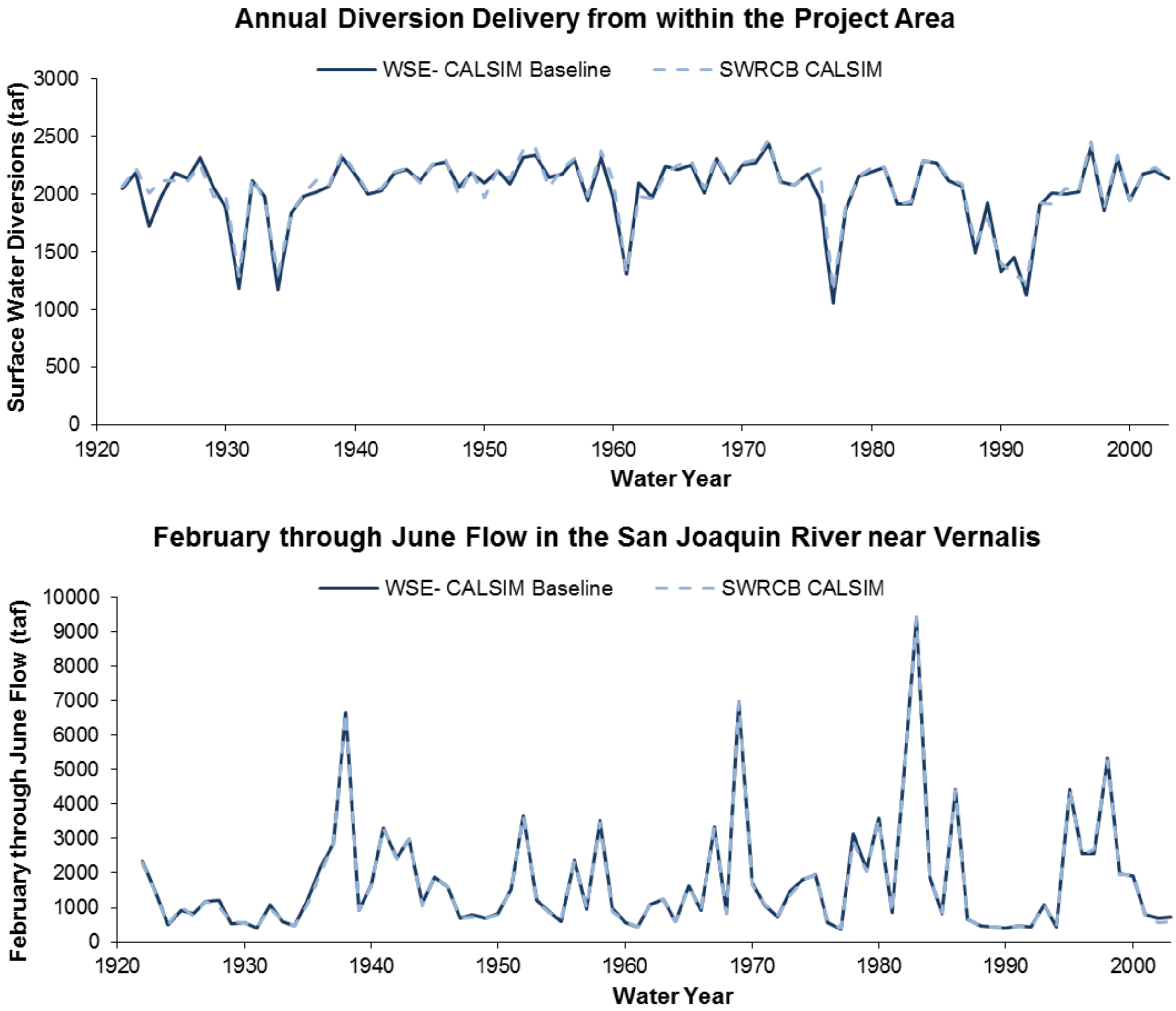

Figure 5-6. Annual WSE Model Baseline[12] SJR Flow at Vernalis and Three Tributary Total Diversion Compared to SWRCB CALSIM Results

The WSE model incorporates 82 years of hydrology that results in the monthly flows, reservoir storage levels, and water supply diversions for each eastside tributary based upon user-specified target flows, other user defined inputs, CALSIM data inputs and outputs, and flood storage rules. User defined inputs to the WSE model include those listed below.

- Months for which flow targets are to be set.
- Monthly flow targets as a percentage of unimpaired monthly flow for each eastside tributary.
- Monthly minimum flows for each eastside tributary.

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[12] This example illustrates the close match between "SWRCB–CALSIM"—i.e., the SWRCB-modified version of USBR SJR Module, compared to WSE model results, prior to further modification of assumptions for surface water demand for the CEQA baseline described in Appendix F.1, *Hydrologic and Water Quality Modeling,* Section F.1.2.4, *Calculation of Monthly Surface Water Demand*.

- Maximum annual surface water diversion for each eastside tributary.
- Minimum annual surface water diversion (may supersede end-of-September storage guidelines).
- Minimum annual end-of-September storage guidelines.
- Maximum annual allowable draw from reservoirs as a percentage of the available storage.

Many CALSIM values used by the WSE model were adapted directly from the USBR CALSIM model run (USBR 2013a, 2013b). Some WSE model inputs not defined by the user include those listed below.

- Monthly surface water demand based on Consumptive Use of Applied Water (CUAW) estimates from CALSIM.
- CALSIM inflows to each major reservoir (New Melones, New Don Pedro, and Lake McClure), and SJR inflow from upstream of the Merced River confluence near Newman.
- CALSIM evaporation rates from each major reservoir.
- CALSIM accretions/depletions and return flows downstream from each major reservoir.
- Flood storage rule curves at each major reservoir.

Calculation of annual diversions for major irrigation districts depends on the amount of surface water available for diversion, which is based on: (1) reservoir storage (March 1 storage minus September 30 storage guideline); (2) projected reservoir inflow (for March 1–September 30); (3) water expected to be lost through evaporation; and (4) water required for instream flow. Surface water demand and minimum diversion requirements control the upper and lower limits of diversions. The available water for diversion is calculated annually using CALSIM hydrologic conditions (inflows) for water years 1922–2003. This methodology allows for maximizing annual diversions based on climate variations; reservoirs can be re-operated to allow additional draw-down relative to baseline and ensure a portion of storage is retained for maintaining river temperatures downstream. To distribute the calculated available seasonal diversion throughout the year, an allocation was determined as a fraction of surface water demands for each of the major irrigation district diversions, then applied to the each month of the irrigation year. More information regarding this calculation is provided in Appendix F.1, *Hydrologic and Water Quality Modeling*.

The following flow requirements are included in the baseline: NMFS BO flows on the Stanislaus River; FERC flows on the Tuolumne and Merced Rivers; and Davis-Grunsky and Cowell Agreement requirements on the Merced River. For the LSJR alternatives, the WSE model uses the maximum of these flow requirements or the percent of unimpaired flow specified for each LSJR alternative.

The modeled baseline is the basis for comparison and determination of water supply and water quality impacts under the LSJR alternatives described in this chapter (Impacts WQ-1–WQ-3).

Adaptive Implementation

Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. This base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K. Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

- Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
- Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
- Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.
- Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (for example monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife.

The quantitative results presented in the figures, tables, and text of this chapter present WSE modeling of the specified unimpaired flow requirement of each LSJR alternative (i.e., 20, 40, or 60 percent). This chapter also incorporates a qualitative discussion of adaptive implementation under each of the LSJR alternatives that includes the potential environmental effects associated with adaptive implementation. To inform the qualitative discussion and account for the variability allowed by adaptive implementation, modeling was performed to predict conditions at 30 percent and 50 percent of unimpaired flow (as reported in Appendix F.1, *Hydrologic and Water Quality Modeling*). The modeling also allows some inflows to be retained in the reservoirs until after June, as could occur under method 3, to prevent adverse temperature effects. This variety of modeling scenarios provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. This chapter incorporates a qualitative discussion of the potential water quality impacts of adaptive implementation under each of the LSJR alternatives. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1. Because flow modification is not part of the SDWQ alternatives, there is no adaptive implementation component of the SDWQ alternatives and adaptive implementation does not have the potential to affect the impact determinations of the SDWQ alternatives.

Water Temperature Model

This section describes the development of the temperature model and the assumptions used to model baseline and LSJR alternative conditions. Comparisons of the baseline and LSJR alternative temperature results are presented in Section 5.4.3, *Hydrologic and River Temperature Modeling Results.* More details of the model development and results are described in Appendix F.1, *Hydrologic and Water Quality Modeling.* To model effects on temperature in the LSJR and three eastside tributaries, the State Water Board modified the *San Joaquin River Basin-Wide Water Temperature and EC Model* (SJR HEC-5Q model, or temperature model) developed by a group of consultants between 2003 and 2008 through a series of CALFED contracts that included peer review and refinement (CALFED 2009). The temperature model was most recently updated by the California Department of Fish and Wildlife (CDFW) and released in June of 2013 (CDFW 2013).

The SJR HEC-5Q temperature model uses the Hydrologic Water Quality Modeling System (HWMS-HEC5Q) to model reservoir and river temperatures subject to historical climate conditions and user-defined operations. The HWMS-HEC5Q is a graphical user interface that employs HEC-5Q, the USACE Hydrologic Engineering Center (HEC) flow and water quality simulation model. The temperature model was designed to provide a SJR basin-wide evaluation of temperature response at 6-hour intervals for alternative conditions, such as operational changes, physical changes, and combinations of the two. The extent of the model includes the Stanislaus, Tuolumne, and Merced River systems from their LSJR confluences to the upstream end of their major reservoirs (i.e., New

Melones, New Don Pedro, and Lake McClure, respectively). The upstream extent of the model is the Merced River confluence. The downstream extent of the model is the LSJR at Mossdale (which is downstream of Vernalis). The model simulates the reservoir stratification, release temperatures, and downstream river temperatures as a function of the inflow temperatures, reservoir geometry and outlets, flow, meteorology, and river geometry. Calibration data was used to accurately simulate temperatures for a range of reservoir operations, river flows, and meteorology.

The temperature model interfaces with CALSIM or monthly data formatted similarly to CALSIM output. A pre-processing routine converts the monthly output to a format compatible with the SJR HEC-5Q model. This routine serves two purposes: (1) to allow the temperature model to perform a long-term simulation compatible with the period used in CALSIM; and (2) to convert monthly output to daily values used in the temperature model.

The State Water Board used the CALSIM-to-HEC-5Q temperature model pre-processor, using the monthly output from the WSE model, and ran the temperature model to determine the river temperature effects of the LSJR alternatives within the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. The temperature model was run for the years 1970–2003, a period with sufficient length and climatic variation to determine the effects of the LSJR alternatives on river temperatures.

Exports and Outflow

The LSJR alternatives have the potential to change the CVP and SWP exports and Delta outflow. Appendix F.1, *Hydrologic and Water Quality Modeling*, details the methodology used to estimate the change in southern Delta exports and Delta outflow. SJR at Vernalis flow changes primarily during the months of February–June. Changes in SJR flow at Vernalis either change exports or change outflow. Based on the existing Delta objectives and NMFS BO rules, the most likely changes in exports for each month were estimated based on the change in flow at Vernalis simulated by the WSE model and the most likely regulation to be controlling Delta exports for a given month (see Table F.1.7-1). To estimate the possible effects on exports, analysis related to exports and outflow assumes the State Water Board will not change the export constraints to protect any increased flows downstream of Vernalis because the LSJR Alternatives as described in Chapter 3, *Alternatives Description*, would not affect export regulations. Results of this analysis are summarized here in Chapter 5, but potential impacts on aquatic resources are discussed in Chapter 7, *Aquatic Biological Resources*, and potential impacts on service providers are discussed in Chapter 13, *Service Providers*. The State Water Board is currently in the process of reviewing the export restrictions included in the 2006 Bay-Delta Plan as part of its periodic review of the plan. Through that process, the State Water Board will determine what changes, if any, should be made to the export restrictions. The State Water Board will then determine what actions are needed to implement changes to the flow and export objectives.

Salinity Analysis

This section describes the methods used to analyze salinity in the southern Delta as a result of implementing the LSJR and SDWQ alternatives. Two potential mechanisms for salinity impacts are described: (1) changes to flow at Vernalis; and (2) changes to circulation, water levels, and tidal flow in the southern Delta.

The SDWQ alternatives would amend the southern Delta salinity objectives identified in the 2006 Bay-Delta Plan. The purpose of the salinity objective in the 2006 Bay-Delta Plan as well as the purpose of the SDWQ alternatives is to protect beneficial uses, specifically agricultural uses in the southern Delta. Currently, the attainment of the objective in the southern Delta is assessed by monitoring EC in the SJR at Vernalis and Brandt Bridge, and in Old River at Middle River (Union Island) and Tracy Boulevard. Under SDWQ Alternatives 2 and 3, the EC objective would be modified. In addition, under the program of implementation, the monitoring locations for assessing attainment of the objective could also be modified, except at Vernalis, to better assess salinity conditions attainment of the water quality objective.

While the monitoring locations could change under SDWQ Alternatives 2 and 3, the historic monitoring locations specified in the 2006 Bay-Delta Plan were used to assess water quality impacts. These historic monitoring locations were used because much data has been collected at these locations, which allows for a quantitative assessment of how the LSJR alternatives may affect water quality at these locations. Estimated changes in water quality at these locations are indicative of how water quality may change at other southern Delta locations.

The potential for changes in salinity to affect the beneficial use of water for aquatic resources, agricultural supply, and drinking water supply are discussed in Chapter 7, *Aquatic Biological Resources*, Chapter 11, *Agricultural Resources*, and Chapter 13, *Service Providers*, respectively.

Vernalis Flow Effects on Salinity

Potential southern Delta salinity impacts associated with LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3 were assessed in two ways.

- By assessing whether the alternatives would increase the number of months with EC above the water quality objectives for salinity at Vernalis or southern Delta compliance stations (impact WQ-1).
- By assessing whether the alternatives would substantially increase southern Delta EC such that agricultural beneficial uses are impaired. The potential overall change in southern Delta salinity for agriculture was evaluated using the long term cumulative distribution for EC during the irrigation season (April–September)(Impact WQ-2).

Salinity at SJR at Vernalis was calculated within the WSE model using a flow-to-salinity ratio based on the CALSIM results. Increases in salinity within the southern Delta were empirically derived based on historic data at Vernalis and the interior southern Delta stations. These methods are summarized here and further discussed in Appendix F.1, *Hydrologic and Water Quality Modeling*.

The WSE model estimated Vernalis EC based on the assumption that the salt load at Vernalis is the same as that modelled by CALSIM using the following equation.

$$\text{Adjusted Vernalis EC} = \text{CALSIM EC} * (\text{CALSIM Flow}/\ \text{Adjusted Flow}) \qquad (\text{Eqn. 5-1})$$

Using this equation, EC decreases under high flow conditions and increases under reduced flow conditions. The Vernalis EC values were calculated in this manner for both baseline conditions and each of the LSJR alternatives. As necessary, the WSE model adjusted the flow releases from New Melones Reservoir on the Stanislaus River to ensure that the Vernalis EC objectives were met.

Appendix F.1, *Hydrologic and Water Quality Modeling,* shows the comparison of measured monthly average SJR at Vernalis EC values and the CALSIM EC results for water years 1994–2003 in Section F.1.42.1, *Salinity Modeling Methods*. This covers a period during which actual operations in the watershed(s) were relatively similar to those modeled in CALSIM.

Simple calculations of the southern Delta EC values were made based on the historical EC increases between Vernalis and the southern Delta stations for 1985–2009 (see Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*). A review of the historical EC data indicated that the EC increment from Vernalis to Brandt Bridge or Old River at Middle River (Union Island) can be estimated with the following flow dilution relationship.

EC increase from Vernalis (dS/m) = 100/ SJR flow at Vernalis (cfs) *(Eqn. 5-2)*

Accordingly, for a flow of 1,000 cfs, the EC increase would be 0.10 dS/m. For a flow of 2,000 cfs, the EC increase would be 0.050 dS/m, and for a flow of 5,000 cfs, the EC increase would be 0.020 dS/m. The EC increase at Old River at Tracy Boulevard was assumed to be 3 times the EC increase at Brandt Bridge.

EC increase from Vernalis (dS/m) = 300/ SJR flow at Vernalis (cfs) *(Eqn. 5-3)*

The quantitative water quality impact analysis focusses on salinity because: (1) salinity is the main water quality constituent likely to be affected by the LSJR and SDWQ alternatives, (2) there is sufficient EC data available to evaluate effects quantitatively, and (3) it is a constituent of great concern in the southern Delta. Other water quality constituents are also included in the impact assessment below, but the analysis is less quantitative. Other water quality constituents are expected to respond to changes in flow in a manner similar to that which is estimated for salinity.

Circulation, Water Levels, and Tidal Flows Effects on Salinity

Salinity conditions in the southern Delta water bodies are affected by their capacity to assimilate upstream and local salt loading. This assimilative capacity is potentially affected by hydrodynamic conditions, such as water levels and the direction and magnitude of flow in the various channels of the southern Delta. CVP and SWP pumping operations in the southern Delta have the potential to affect water level and flow conditions there. To address these impacts, the temporary barriers are currently installed during the irrigation season in Old River near the DMC, in Grant Line Canal at Tracy Boulevard Bridge, and in Middle River at Victoria Canal. The temporary barriers block the tidal flows during ebb tide (falling water elevations, water moving downstream towards the estuary), and thereby maintain higher elevations during ebb tides. The Grant Line barrier is placed each year at a lower elevation than the other two barriers.

The SDWQ alternatives call for continuation of the temporary barriers, followed by special studies and development of a coordinated operations plan. The existing water levels in the southern Delta channels, therefore, would not change with the LSJR or SDWQ alternatives evaluated in this SED. As a result, barrier operations and associated effects on circulation, water level, and tidal flows would have either no impact or provide a slight improvement in salinity conditions in the southern Delta (due to the coordinated operations plan) and are not discussed further.

303(d) Pollutant Analysis

Pollutants identified by the 303(d) list for the various receiving waters in the study area (Table 5-4) are more likely to approach criteria levels when river flows are relatively low because concentrations of pollutants generally increase when flows are low. An increase in flows would not likely cause concentrations to exceed criteria levels. Although some data are available for these pollutants, there was not a sufficient number of water quality measurements for each month over the range of baseline flows to be able to calculate concentrations or loads; therefore, a generalized more qualitative evaluation of changes in pollutant concentrations, based on changes in flows expected for each of the LSJR alternatives, was used to evaluate whether the LSJR alternatives would result in an increase in 303(d) pollutant concentrations. The impact assessment for general pollutant concentrations is based on the changes in the monthly cumulative distributions of flows. The likely changes in pollutant concentration were assessed using the percent change in the 10th percentile and median flows (Impact WQ-3). The evaluation is conservative because it assumes that baseline concentrations of 303(d) pollutants would approach or exceed water quality criteria limits.

Plan Area and Water Supply Effects Model

The water supply effects analysis, WSE model, and overall analysis of impacts on other resources in the SED focus on the plan area downstream of the rim dams (New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure), where the flow objectives attain the greatest benefits on the Stanislaus, Tuolumne, and Merced Rivers. The assessment of water supply effects in the plan area downstream of the rim dams provides an adequate means of identifying and evaluating effects for the overall analysis because the effects below the rim dams largely represent the potential effects of the LSJR alternatives overall. Upstream areas above the rim dam reservoirs are not included in the WSE model because upstream water rights are relatively small compared to the downstream rights and, thus, any changes in operations due to the project alternatives are assumed not to significantly affect inflows into New Melones Reservoir, New Don Pedro Reservoir, or Lake McClure. Although water rights in the extended plan area above the rim dams could also be affected by implementation of the flow objectives, the effect would be small compared to the effect downstream of the rim dams. The impact analysis therefore addresses those potential effects in less detail than for downstream areas.

An illustration of the proportion of water use below the rim dams compared to the proportion in the extended plan area can be shown using the face value of post-1914 water rights for consumptive use in each region. The allocation of responsibility to implement the objectives would generally follow water right priority and other applicable law. In general, the rule of priority requires junior water right holders to reduce water diversions when water is not available for diversion by all water right holders. The face-value of non-hydropower post-1914 water rights upstream of the rim dams in the extended plan area account for approximately 2 percent, 1 percent, and 6 percent of the post-1914, non-hydropower water in the Stanislaus, Tuolumne, and Merced River Watersheds, respectively.[13] Large post-1914 rights downstream of the rim dams, in the plan area, include the following.

- Three non-power water rights held by the Merced ID for water diverted at or downstream of Lake McClure account for approximately 98 percent of the post-1914 water authorized for diversion in the Merced River Watershed.
- Five non-power water rights held by TID and MID for water diverted at or downstream of New Don Pedro Reservoir account for approximately 99 percent of the post-1914 water authorized for diversion in the Tuolumne River Watershed (not including CCSF diversions at Hetch Hetchy authorized by the Raker Act of 1913).

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[13] These numbers do not include upstream water rights that are owned and operated by major irrigation districts, e.g., Donnells and Beardsley Reservoirs operated by the Tri-Dam Project, to be used consumptively within the plan area downstream of the rim dams, and assessed as a portion of the rim dam inflows.

- 16 non-power water rights held by OID, SSJID, USBR, McMullin Reclamation District #2075, and River Junction Reclamation District #2064 for water to be consumptively used downstream of New Melones Reservoir account for 94 percent of the post-1914 water authorized for diversion in the Stanislaus River Watershed.

These and other water users downstream of the rim dams also rely on significant pre-1914 water rights. Given the small volume of water held in non-hydropower post-1914 rights for consumptive use in the extended plan area compared to the volume held in non-hydropower post-1914 water rights used below the rim dams, most of the effect of implementing LSJR alternatives would occur at, or downstream of, the major rim dams in the Stanislaus, Tuolumne, and Merced Rivers.

The Tuolumne River has a significant upstream diversion (e.g., CCSF, Hetch Hetchy aqueduct). The water rights and operating agreement for New Don Pedro Reservoir includes requirements for seasonal storage in the CCSF upstream reservoirs and water banking in New Don Pedro Reservoir allocated between TID, MID, and CCSF, as described above in Section 5.2.4, *Tuolumne River*. The water accounting for New Don Pedro Reservoir could be modified by the LSJR alternatives, but the upstream CCSF operations (storage, hydropower, and water diversion volume) are assumed to be mostly unchanged and therefore would not significantly affect the release of the flows required for the alternatives from New Don Pedro and, therefore, is not part of the WSE model. Depending on the operating agreements between MID, TID, and CCSF, there is some potential that CCSF water supply and operations could be affected during dry conditions. This potential effect is evaluated in Chapter 13, *Service Providers*, Chapter 20, *Economic Analyses*, and Appendix L, *City and County of San Francisco Analyses*.

Extended Plan Area

The primary means by which the extended plan area reservoirs and rivers might be affected is if water is bypassed by junior water rights holders, in accordance with the rules of priority and applicable law, to achieve the required flows in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.

Under baseline, junior water rights holders who divert water to storage, including February through June, must cease diversion to storage if there is not enough water to satisfy the water rights of more senior water rights downstream. The frequency with which these junior water rights holders must cease diversion to storage would increase during some months of some years under LSJR Alternatives 2, 3, and 4 if water needed to meet the February–June flow requirements reduces the amount of water that can be diverted. A reduction in diversion to storage in the upstream reservoirs can result in reduced reservoir levels, which already occur in the baseline condition. The increased frequency with which reservoirs in the extended plan area are drawn down to lower storage levels would depend on seniority of water rights and how water rights are conditioned to implement the flow objectives in a future water right proceeding. While the effects may be greatest in critically dry and dry years, there may be some effects in below normal, above normal, and wet years. Table 5-19b shows the distribution of changes to annual average diversions under each of the LSJR alternatives.

The increased frequency of lower reservoir levels and the related physical changes, however, would be limited by the program of implementation, which states that the State Water Board will include minimum reservoir carryover storage targets or other requirements to help ensure that providing flows to meet the flow objectives will not have adverse temperature or other impacts on fish and wildlife or, if feasible, on other beneficial uses. It also states that the State Water Board will also take actions as necessary to ensure that implementation of the flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods. Accordingly, when the State Water Board implements the flow requirements, it will consider impacts on fish, wildlife and other beneficial uses and health and safety needs, along with water right priority. Any project-level proceeding would require compliance with CEQA, and the State Water Board would consider project-specific impacts associated with lower reservoir levels, and mitigate any significant impacts. This could, for example, result in establishing bypass limitations for reservoirs that store water for non-consumptive uses or providing flexibility, such as shifting the timing of release, in meeting such requirements for those reservoirs. Water required to satisfy senior rights could be temporarily retained in upstream reservoirs as long as it is released later when the water is needed for use under senior rights downstream. This approach is consistent with the physical solution doctrine, which allows for measures such as alternative supplies—in this case storage under upstream, junior water rights instead of bypassing that water for storage under downstream, senior water rights, while still making that water available when needed under the downstream, senior rights—that serve to maximize beneficial use while avoiding injury to water right holders.

The LSJR alternatives could temporarily increase river flows in the extended plan area relative to baseline as a result of bypassing direct diversions or reducing diversions to storage. The increases in flows could occur more frequently and be a larger volume of water under the higher unimpaired flow alternatives (e.g., LSJR Alternative 4). Later in the year, flows potentially could be reduced if reservoir storage is too low; however, as described in the program of implementation, there would be limits on, or shifting of the timing of, bypass requirements, which would reduce this effect.

In this chapter, the analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

Hydrologic and River Temperature Modeling Results

This section includes a summary of the hydrologic and river temperature modeling results, including an evaluation of the changes in flow, diversions, reservoir storage, and water temperature estimated to occur under LSJR Alternatives 2, 3, and 4 relative to baseline. These four hydrologic parameters are the primary parameters used to evaluate the impacts of many of the resources analyzed in this SED, but impacts on many of the resources are not evaluated based solely on these parameters. These parameters are discussed below to describe how they may change in response to the LSJR alternatives. The impacts driven by these parameters are discussed in the appropriate resource chapters of the SED. Water quality, however, is evaluated within specific impacts in this chapter in Section 5.4.4, *Impact and Mitigation Measures* (Impacts WQ-1, WQ-2, and WQ-3), and thus a summary and evaluation of those results are contained within those impact discussions.

Detailed hydrologic and river temperature results for the baseline and each of the LSJR alternatives can be found in Appendix F.1, *Hydrologic and Water Quality Modeling*. In later chapters, the analysis of the hydrologic conditions is tailored to the specific resource and the potential impact being evaluated. These later chapters either make use of the model result summaries provided here or evaluate the modeling results in a manner to focus on the resource of concern.

Potential project-related changes in river flow, surface water diversions, reservoir storage, and water temperature are summarized in this chapter, but their potential impacts are described in other resource chapters. These include, but are not limited to the following.

- Potential effects associated with changes in river flow are discussed in Chapter 6, *Flooding, Sediment, and Erosion*; Chapter 7, *Aquatic Biological Resources*; Chapter 8, *Terrestrial Biological Resources*; Chapter 10, *Recreational Resources and Aesthetics*; and Chapter 12, *Cultural Resources*.
- Potential effects associated with changes in diversions from the rivers and the southern Delta are discussed in Chapter 7, *Aquatic Biological Resources*; Chapter 9, *Groundwater Resources*; Chapter 11, *Agricultural Resources*; Chapter 13, *Service Providers*; and Chapter 14, *Energy and Greenhouse Gases*.
- Potential effects associated with changes in reservoir storage are discussed in Chapter 7, *Aquatic Biological Resources*; Chapter 8, *Terrestrial Biological Resources*; Chapter 10, *Recreational Resources and Aesthetics*; and Chapter 12, *Cultural Resources.* The changes in reservoir elevation described here also can produce impacts associated with changes in hydropower, which are discussed in Chapter 14, *Energy and Greenhouse Gases*.
- Potential effects associated with changes in water temperature are discussed in Chapter 7, *Aquatic Biological Resources*.

In addition, a description of potential aquatic resource benefits associated with modeled changes are described in Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30,* and a description of potential economic effects associated with the modeled changes are described in Chapter 20, *Economic Analyses.*

Presentation of Results

The WSE model was used to simulate monthly hydrologic parameters for baseline and each LSJR alternative. A time series of the New Melones Reservoir storage (Figure 5-7) is shown as an example of the monthly model output of storage generated for the 82-year modeling period. The annual February–June flow at Ripon is shown in Figure 5-8, and annual diversions from the Stanislaus River in Figure 5-9. Similar results for the Tuolumne and Merced Rivers and for the SJR at Vernalis are shown in Appendix F.1, *Hydrologic and Water Quality Modeling*.

The evaluation of change in hydrologic parameters in this chapter and other chapters of this SED was based on the monthly cumulative distribution of values rather than individual changes in monthly values. As discussed previously in Section 5.2.2, *Upper San Joaquin River*, the cumulative distribution of monthly values is a better metric to describe the overall effects of the LSJR alternatives.

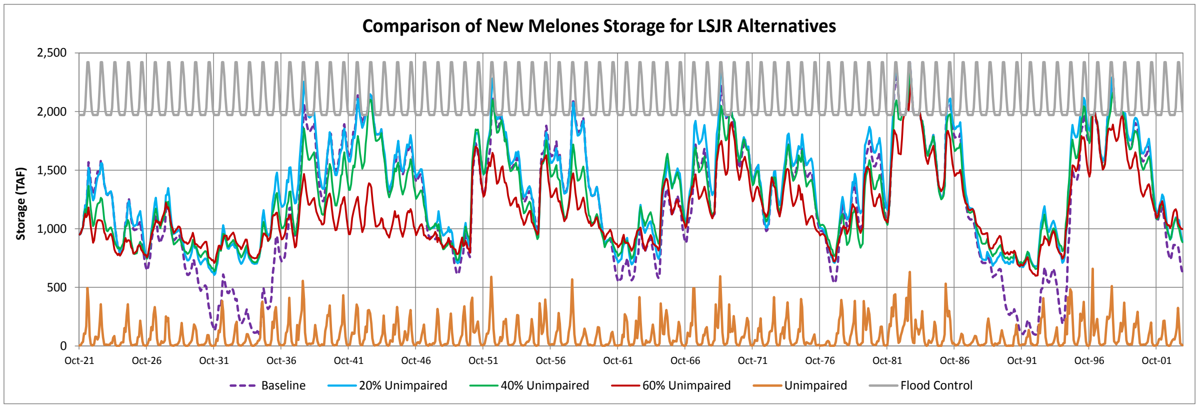

Figure 5-7. Comparison of WSE Model Results for Baseline and LSJR Alternatives: New Melones Reservoir Storage for 1922–2003 (TAF = thousand acre-feet)

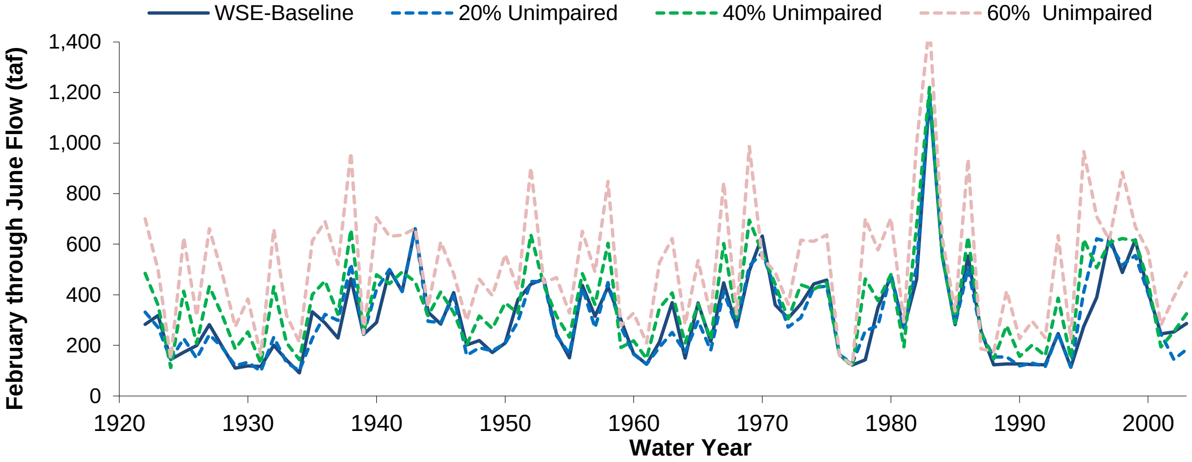

Figure 5-8. Comparison of WSE Model Results for Baseline and LSJR Alternatives: Stanislaus River Total February–June Flows for 1922–2003

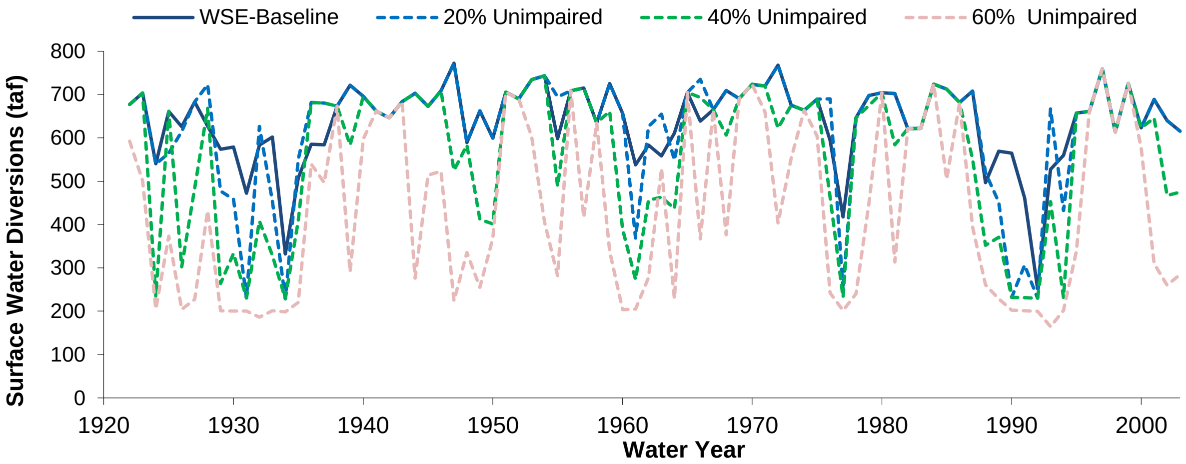

Figure 5-9. Comparison of WSE Model Results for Baseline and LSJR Alternatives: Stanislaus River Diversions for 1922–2003 (TAF = thousand acre-feet)

River Flow

As a general comparison of the LSJR alternatives, the baseline February–June flow volumes (TAF) and average changes to the February–June flow volumes are presented in Table 5-16 for the three eastside tributaries at their confluence with the LSJR and SJR at Vernalis. Average February – June flows increased under each of the LSJR alternatives for all rivers, with the exception of the Stanislaus River under LSJR Alternative 2, which experienced a decrease of 1 percent relative to baseline.

Table 5-16. Average February–June Baseline Flow and Differences from Baseline in the Eastside Tributaries and the SJR at Vernalis for the LSJR Alternatives for the 82-year Modeling Period

	Stanislaus River at Ripon TAF/ (%)	Tuolumne River at Modesto TAF / (%)	Merced River at Stevinson TAF / (%)	SJR at Vernalis TAF/ (%)
Baseline	312 / (100)	562/ (100)	242/ (100)	1,742/ (100)
LSJR Alternative 2 Difference from Baseline	-3 / (-1)	32 / (6)	27 / (11)	56 / (3)
LSJR Alternative 3 Difference from Baseline	62 / (20)	135 / (24)	91 / (38)	288 / (17)
LSJR Alternative 4 Difference from Baseline	203 / (65)	332 / (59)	193 / (80)	728 / (42)

Note: Resulting flow effects on the tributaries are as calculated near the confluence with the LSJR, specifically at Ripon, Modesto, and Stevinson.
TAF = thousand acre-feet

Tables 5-17a through 5-17d show the 10, 50, and 90 percent cumulative distributions (i.e., 10th, 50th, 90th percentiles) under the LSJR alternatives. These tables summarize the modeled effects of the LSJR alternatives at low, median, and high flows and show the variations from month-to-month and the magnitude of some of the largest percent increases. In general, during the objective months of February–June, the LSJR alternatives caused an increase in flows on all the rivers. There were also smaller changes to flow outside of these months on all the rivers, especially under LSJR Alternatives 3 and 4. Some river specific changes under the LSJR alternatives are noted below.

- On the Merced River, the percent increases in flow from the LSJR alternatives were smaller in February–March than in April–June (Table 5-17a). This occurred because from February–March, under baseline conditions, often there was already a relatively high percent of unimpaired flow released. The largest percent increase in both low and median flows was for the Merced River in May and June under LSJR Alternative 4. Under low (10th percentile) flow conditions in May, modeled flow for LSJR Alternative 4 were more than seven times the baseline flow. Large percent increases at low flow can be helpful to biological resources during periods of water stress. Percent increases in the median flows indicate a substantial change in the frequency of higher flows.
- On the Tuolumne River, the percent increases in flow from the LSJR alternatives were smaller in February–April than in May and June (Table 5-17b). This occurred because from February–April, under baseline conditions, often there was already a relatively high percent of unimpaired flow released.
- On the Stanislaus River (Table 5-17c), LSJR Alternative 2 had little effect on river flow, whereas LSJR Alternatives 3 and 4 generally produced increases in flow. The percentages of increase from April–June on the Stanislaus River were generally less than the percentages of increase on the Merced and Tuolumne Rivers because the baseline releases were already relatively high.

As shown in Tables 5-17a through 5-17d, the LSJR alternatives can also affect flows from July–January. This is due to changes in the flow requirements and diversions, which in turn affect reservoir storage relative to baseline. Two specific reasons for changes in July–January flow under the LSJR alternatives are: (1) changes to the flood control releases, and (2) adaptive implementation to shift some of the additional February–June flow to later in the year.

First, when the LSJR flow alternatives require more flow to be released February–June, in many years the storage by the end of June may end up lower than it did under baseline. If this occurs, the potential for flood control releases from July–January is also reduced, especially for the reservoirs that are small relative to watershed runoff volume (i.e., Lake McClure and New Don Pedro Reservoir), and thus flow in July through the following January can be reduced relative to baseline. In the modeling results, this occurred many times during years of high inflows and led to a change in the cumulative distribution during these months. For example, under LSJR Alternative 4, increased flood control space caused a 57 percent reduction in the 90th percentile flows in the Merced River in December and July, and a 64 percent reduction in the 90th percentile flows in the Tuolumne River in July. The reduced flood control releases can also occur during February–June if carryover storage has been reduced relative to baseline, leaving more space to retain flood waters.

Second, as described in the program of implementation, with adaptive implementation, some of the February–June flow can be retained in storage and released later in the year to reduce potential increases in river temperature. This typically occurs under LSJR Alternatives 3 and 4 and was modeled by shifting a portion of the additional February–June water to be released from July–November in wet years for all three rivers, from July–September in above normal years in the Merced River only, and during October for all year types in the Stanislaus River (for more specific details regarding flow shifting, see Appendix F.1, *Hydrologic and Water Quality Modeling,* Section F.1.2.7, *Calculation of River and Reservoir Water Balance*). This adaptive implementation maintains the colder temperatures generally experienced in wet water years due to flood control releases and maintains similar temperatures as baseline conditions for these year types by increasing flow during these months. Due to the increased flows of LSJR Alternatives 3 and 4, there is a reduced potential for flood control releases that causes flows to occasionally be reduced relative to baseline. Without adaptive implementation, these two alternatives may otherwise reduce the flows, resulting in temperature increases relative to baseline. The adaptive implementation, in part, leads to the changes in the cumulative distributions of flow from July–January, with increases in flows most apparent in September–November.

- There are several additional reasons why the LSJR alternatives may cause flow to change on the Stanislaus River, which explain some of the results presented in Table 5-17c.VAMP—Under baseline conditions, VAMP pulse flow requirements at Vernalis for April 15–May 15 resulted in additional releases from the rivers; however, VAMP is not part of the LSJR alternatives.
- D-1641 flow requirements—Under baseline conditions, water from the Stanislaus River was used to meet D-1641 flow requirements for flow at Vernalis from February 1–April 14 and May 16–June 30; however, these flow requirements are not part of the LSJR alternatives.
- Vernalis EC objectives—The Vernalis EC objectives are met under baseline conditions and in all LSJR alternatives. Water from the Stanislaus River is sometimes released to attain the Vernalis EC objective. The need for this release is dependent on flows from the other rivers, which varies with the alternatives.
- NMFS BO flows—Under baseline conditions and the LSJR alternatives, flows in the Stanislaus River must be at least as high as the NMFS BO flows. However, the NMFS BO flows vary depending on reservoir storage, so the baseline and alternative NMFS BO flows are not always the same.

Table 5-17a. Flow Summary for the Merced River at Stevinson—Monthly Cumulative Distributions of Baseline Flow and Differences from Baseline for the LSJR Alternatives for the 82-year Modeling Period

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Merced Flow at Stevinson (cfs)—Baseline												
10	325	266	277	280	312	283	150	117	88	55	32	55
50	423	338	348	385	450	384	508	473	225	155	163	170
90	548	419	991	1,621	2,556	1,728	973	2,478	2,981	2,113	1,150	544
Alternative 2—Percent difference from Baseline												
10	0	2	1	0	0	5	89	182	96	0	-7	-4
50	0	1	0	-2	4	4	-6	67	118	-1	-5	-2
90	3	4	5	6	12	0	-6	-1	-11	0	1	0
Alternative 3—Percent difference from Baseline												
10	5	2	-3	-5	4	18	259	465	230	0	10	1
50	1	4	-2	-2	1	34	69	201	304	29	22	18
90	46	91	-56	6	-16	0	36	2	-12	-13	0	10
Alternative 4—Percent difference from Baseline												
10	5	2	-2	-7	6	38	438	747	396	0	10	1
50	1	4	-2	-4	29	100	157	364	511	29	22	18
90	46	91	-57	-6	-7	0	101	29	-9	-57	-7	10

cfs = cubic feet per second

Table 5-17b. Flow Summary for the Tuolumne River at Modesto—Monthly Cumulative Distributions of Baseline Flow and Differences from Baseline for the LSJR Alternatives for the 82-year Modeling Period

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Tuolumne Flow at Modesto (cfs) —Baseline												
10	290	246	257	316	312	349	546	546	270	262	277	256
50	550	464	470	570	647	1,568	1,414	1,238	499	448	426	422
90	813	756	1,152	3,424	5,084	5,097	4,591	4,810	4,387	3,331	652	691
Alternative 2—Percent difference from Baseline												
10	0	0	0	0	11	24	16	27	38	0	0	0
50	0	-1	0	-3	24	-7	-6	19	130	0	0	0
90	0	0	-20	0	-10	-1	0	5	0	0	0	0
Alternative 3—Percent difference from Baseline												
10	0	0	0	0	42	74	104	154	123	0	0	0
50	0	2	-4	-5	39	-25	41	132	335	8	0	1
90	23	32	-41	-30	-20	-1	0	0	1	-6	0	45
Alternative 4—Percent difference from Baseline												
10	0	0	0	0	68	136	194	281	235	0	0	0
50	0	2	-4	-4	100	3	88	252	559	8	0	1
90	23	32	-41	-36	-22	-13	-11	32	29	-64	0	45

cfs = cubic feet per second

Table 5-17c. Flow Summary for the Stanislaus River at Ripon—Monthly Cumulative Distributions of Baseline Flow and Differences from Baseline for the LSJR Alternatives for the 82-year Modeling Period

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Stanislaus Flow at Ripon (cfs)—Baseline												
10	729	248	224	270	230	308	573	525	292	293	302	311
50	889	319	288	337	385	486	1,556	1,422	629	437	416	419
90	1,116	454	421	576	1,285	1,911	1,997	2,107	1,655	705	632	667
Alternative 2—Percent difference from Baseline												
10	4	0	1	0	4	2	5	5	8	1	3	0
50	2	0	1	2	1	-15	-4	-3	24	0	2	2
90	1	0	0	5	2	0	-7	-3	-7	3	0	3
Alternative 3—Percent difference from Baseline												
10	10	0	1	-1	16	21	21	44	8	5	3	-4
50	26	0	1	0	35	42	-1	25	77	0	2	0
90	25	-2	0	-6	40	-1	-3	29	24	13	-12	20
Alternative 4—Percent difference from Baseline												
10	10	0	1	-1	41	50	75	76	33	2	-8	-6
50	25	0	0	1	99	106	22	85	146	-3	-1	0
90	25	-3	-3	-9	75	16	33	97	90	17	-8	20

cfs = cubic feet per second

Table 5-17d. Flow Summary for the SJR at Vernalis—Monthly Cumulative Distributions of Baseline Flow and Differences from Baseline for the LSJR Alternatives for the 82-year Modeling Period

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
San Joaquin River Flow at Vernalis (cfs)—Baseline												
10	2,000	1,566	1,513	1,481	1,856	1,614	1,616	1,543	1,009	959	1,055	1,488
50	2,598	1,981	1,941	2,200	3,489	3,502	4,640	4,600	2,280	1,620	1,544	2,024
90	3,331	2,724	4,264	10,926	15,228	13,821	12,538	13,327	11,586	6,902	2,983	2,940
Alternative 2—Percent difference from Baseline												
10	0	0	0	0	-4	0	16	43	10	0	0	0
50	0	0	0	1	4	3	-8	-2	46	1	1	0
90	0	2	-9	2	-2	0	5	8	1	0	2	9
Alternative 3—Percent difference from Baseline												
10	0	0	0	0	0	8	73	109	52	0	0	-2
50	9	1	0	-2	-12	13	16	59	122	1	2	0
90	20	23	-29	-14	-20	-1	7	19	3	-8	0	21
Alternative 4—Percent difference from Baseline												
10	0	0	0	0	5	42	137	181	104	0	0	-2
50	9	1	0	-2	7	38	55	121	209	0	0	-1
90	21	26	-29	-29	-3	-2	11	45	23	-36	-1	21

cfs = cubic feet per second

Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June minimum flow requirement. Table 5-18 provides an evaluation of the Vernalis flow requirement using the WSE model. It indicates that changes due to method 4 under all alternatives would rarely alter the flows in the three eastside tributaries or the LSJR. The 1,000 cfs requirement is included in the WSE model simulations of the LSJR alternatives as evaluated in the SED. Increasing this requirement to 1,200 cfs or reducing it to 800 cfs would affect very few months because the Vernalis flows under the LSJR alternatives are generally greater than 1,200 cfs during February–June. For example, under LSJR Alternative 4, if the minimum Vernalis flow requirement were increased as part of adaptive implementation from 1,000 cfs to 1,200 cfs, then the number of months affected by the Vernalis flow requirement would increase from 1 month to 3 months out of the 410 that were simulated.

Table 5-18. Number and Percent of Months Affected by February–June Minimum Vernalis Flow Requirements Based on the 82 Years Simulated by the WSE Model

	800 cfs		1,000 cfs		1,200 cfs	
	Number	Percent	Number	Percent	Number	Percent
LSJR Alternative 2	2	0.5	3	0.7	11	2.7
LSJR Alternative 3	1	0.2	1	0.2	5	1.2
LSJR Alternative 4	0	0.0	1	0.2	3	0.7

cfs = cubic feet per second

Water Diversions

The LSJR alternatives could require higher river flows in the three eastside tributaries and would potentially result in a change in surface water diversions. The runoff to the eastside tributary reservoirs is determined by rainfall and snowmelt conditions and the reservoir storage capacity is fixed. Accordingly, there is no possibility of increasing the total surface water supply to provide more water for surface water diversions. More water released to the rivers under the LSJR alternatives means, generally, there would be less water available for water supply diversions. The WSE model was used to predict the change in annual surface water diversions expected under each LSJR alternative and the results are presented here to provide a description of the magnitude of change under each of the alternatives.

Additionally, as discussed above in Section 5.4.2, *Methods and Approach*, the CVP and SWP exports could be modified based on the inflow from the LSJR. Because the WSE model does not simulate Delta exports, changes in exports were estimated from changes in flow at Vernalis and the Delta regulations that affect exports for each month. These changes were compared to the average historic exports for 1995–2013 (years since the Bay-Delta Plan was introduced).

Table 5-19a shows the simulated average differences in water supply diversions between baseline and the LSJR alternatives. The results indicate that there would be small reductions in water supply under LSJR Alternative 2, moderate water supply reductions under LSJR Alternative 3, and greater water supply reductions under LSJR Alternative 4. Table 5-19b shows the percentiles of these diversions in baseline and the LSJR alternatives, showing that the differences are greatest in drought years, e.g., 10th percentile.

Table 5-19a. Average Annual Baseline Water Supply and Differences from Baseline (Changes in Diversions) in the Eastside Tributaries and Plan Area for the LSJR Alternatives for 1922–2003

	Stanislaus (TAF) / (%)	Tuolumne (TAF) / (%)	Merced (TAF) / (%)	LSJR Plan Area (TAF) / (%)
Baseline	637 / 100	851 / 100	580 / 100	2,068 / 100
LSJR Alternative 2	-12 / -2	-20 / -2	-33 / -6	-65 / -3
LSJR Alternative 2 or LSJR Alternative 3 with Adaptive Implementation (30 percent unimpaired flow)[a]	-33/-5	-56/-7	-60/-10	-149/-7
LSJR Alternative 3	-79 / -12	-119 / -14	-95/ -16	-293 / -14
LSJR Alternative 4	-206 / -32	-298 / -35	-185 / -32	-689 / -33

TAF = thousand acre-feet
TAF/y = thousand acre-feet per year

[a] WSE model results for 30 percent unimpaired flow are included in this table because they are relevant to impact determination in Chapter 13, *Service Providers,* under LSJR Alternatives 2 or 3.

Table 5-19b. Distribution of Changes in Average Annual Diversions Associated with the LSJR Alternatives

Percentile	Baseline Annual Diversions (TAF)	Percent Change			
		LSJR Alternative 2	LSJR Alternative 2 with AI (30 percent unimpaired flow)	LSJR Alternative 3	LSJR Alternative 4
Stanislaus River					
10	538	-16.0%	-40.6%	-50.8%	-62.6%
50	661	1.8%	0.5%	-3.2%	-39.7%
90	723	0.1%	0.1%	-1.5%	-4.5%
Tuolumne River					
10	685	-4.8%	-20.7%	-40.4%	-66.6%
50	878	-1.0%	-3.0%	-8.6%	-38.8%
90	960	-0.3%	-2.3%	-5.4%	-11.1%
Merced River					
10	441	-13.7%	-30.2%	-41.1%	-50.0%
50	617	-4.8%	-9.2%	-10.6%	-38.3%
90	669	-1.6%	-4.0%	-5.6%	-13.4%
Total					
10	1,783	-16.1%	-33.4%	-44.9%	-63.4%
50	2,135	-0.7%	-2.5%	-8.3%	-38.4%
90	2,341	-0.7%	-2.5%	-4.9%	-10.2%

Tables 5-20a and 5-20b show the annual cumulative distribution for the WSE model simulated water supply diversions and the percentage of full demand for diversion that is met for the Stanislaus, Tuolumne, and Merced Rivers. These cumulative distribution values are based on the 82-years simulated by the WSE model and capture the historic range of hydrologic conditions. The annual values are calculated by irrigation year, which runs from March–February. Shortages typically are greater during drier conditions and are represented by low values for the percentage of demand for diversion that is met.

Diversions are reduced in dry years when the reservoir storage is not sufficient to supply the total demands. On the Stanislaus River, the baseline average annual diversion of 637 TAF was reduced by 12 TAF/y (2 percent), 79 TAF/y (12 percent), and 206 TAF/y (32 percent) for LSJR Alternative 2, LSJR Alternative 3, and LSJR Alternative 4, respectively. On the Tuolumne River, the baseline average annual diversion of 851 TAF was reduced by 20 TAF/y (2 percent), 119 TAF/y (14 percent), and 298 TAF/y (35 percent) for LSJR Alternative 2, LSJR Alternative 3, and LSJR Alternative 4, respectively.

On the Merced River, the baseline average annual diversion of 580 TAF was reduced by 33 TAF/y (6 percent), 95 TAF/y (16 percent), and 185 TAF/y (32 percent) for LSJR Alternative 2, LSJR Alternative 3, and LSJR Alternative 4, respectively. The percent change in diversions associated with each alternative was similar for all three rivers, with the biggest difference only being 4 percent.

Reductions in diversions were mirrored by decreases in the ability to meet full demands. For all three rivers, baseline demand for diversion was fully met in more than half the years and, on average, more than 90 percent of the demand for diversion was met, with the Stanislaus River meeting full demands less often than the Merced River, and the Merced River meeting full demands less often than the Tuolumne River. Under LSJR Alternative 2, there were slight (2–5 percent) decreases in the average percentage of demand that was met. Under LSJR Alternative 3, the average percentage of demand met decreased to approximately 80 percent for all three rivers, and under LSJR Alternative 4, the average percentage of demand met decreased further to 62 percent, 63 percent, and 64 percent for the Stanislaus, Tuolumne, and Merced Rivers, respectively.

Table 5-20a. Annual Cumulative Distributions of Unimpaired Runoff and Water Supply Diversions[14] for Baseline and LSJR Alternatives 2, 3, and 4 (20, 40, and 60 Percent Unimpaired Flow) for Irrigation Years 1922–2003 (TAF)

	Stanislaus					Tuolumne					Merced				
Percentile	Unimpaired Flow	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Unimpaired Flow	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Unimpaired Flow	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Minimum	155	252	228	228	164	384	557	371	341	214	151	136	203	203	202
10	456	538	452	265	201	836	685	652	408	229	408	441	380	259	220
20	592	583	570	403	221	1,055	796	781	563	287	489	558	472	353	243
30	680	605	624	464	260	1,166	828	822	641	378	560	578	551	408	284
40	891	630	657	584	322	1,413	855	852	763	460	669	602	565	467	323
50	1,095	661	673	640	399	1,783	878	869	802	538	895	617	587	551	380
60	1,264	676	687	663	510	2,036	891	889	828	673	1,086	630	603	564	442
70	1,368	694	701	679	601	2,198	915	910	859	763	1,169	643	619	582	494
80	1,563	708	709	695	661	2,490	932	930	887	820	1,399	653	632	607	557
90	1,910	723	724	712	690	3,090	960	957	908	853	1,706	669	659	632	580
Maximum	2,954	772	772	759	759	4,630	1,034	1,034	1,004	907	2,790	680	673	673	648
Average	1,118	637	624	558	431	1,851	851	831	732	553	958	580	547	485	395

TAF = thousand acre-feet

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[14] Diversions include major district diversions, CVP contractor diversions on the Stanislaus River, and riparian diversion totals from all three rivers.

Table 5-20b. Annual Cumulative Distributions of Percentage of Demand for Diversion Met for Baseline and LSJR Alternatives 2, 3, and 4 (20, 40, and 60 Percent Unimpaired Flow) for Irrigation Years 1922–2003

	Stanislaus				Tuolumne				Merced			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Minimum	36	32	31	25	57	38	35	23	19	30	30	30
10	77	62	37	28	76	71	46	25	70	57	40	33
20	81	85	55	29	100	93	59	29	94	71	54	37
30	86	87	67	36	100	100	69	38	100	87	61	44
40	92	100	82	46	100	100	83	50	100	96	73	50
50	100	100	98	55	100	100	98	57	100	100	89	59
60	100	100	100	73	100	100	100	76	100	100	100	69
70	100	100	100	88	100	100	100	84	100	100	100	77
80	100	100	100	100	100	100	100	100	100	100	100	100
90	100	100	100	100	100	100	100	100	100	100	100	100
Maximum	100	100	100	100	100	100	100	100	100	100	100	100
Average	91	89	80	62	95	93	82	63	92	87	78	64

Table 5-21 gives a summary of the CVP and SWP export calculations from Appendix F.1, *Hydrologic and Water Quality Modeling*. This table shows the expected changes in exports that would likely be caused by monthly SJR flow changes as a result of the LSJR alternatives.

Table 5-21. Cumulative Distribution of Estimated Changes in CVP and SWP Exports Caused by Changes in SJR Flow at Vernalis for the LSJR Alternatives (TAF)

	Historical 1995–2013[a]		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
	Annual Exports	Feb–June Exports	Annual Exports Change	Feb–June Exports Change	Annual Exports Change	Feb–June Exports Change	Annual Exports Change	Feb–June Exports Change
Minimum	3,520	890	-74	-61	-190	-140	-376	-36
Median	5,081	1,484	9	8	69	58	187	196
Maximum	6,573	2,277	158	134	329	301	592	579
Average	5,185	1,525	18	16	76	67	194	211

TAF = thousand acre-feet

[a] based on DAYFLOW data

The calculated annual changes in CVP and SWP southern Delta exports were minimal. The estimated average annual change for Alternative 2 was an increase of 18 TAF/y and the estimated average annual change for LSJR Alternative 3 was an increase of 76 TAF/y. Both of these numbers are small compared to the historic annual average export of 5,185 TAF (data for water years 1995–2013).

The estimated annual changes in CVP and SWP southern Delta exports for LSJR Alternative 4 averaged 194 TAF/y. This small increase is approximately 4 percent of the historic average annual export of 5,185 TAF/y. On a year-by-year basis, the changes compared to baseline were often larger than the average change, but still small compared to total exports, and years with decreases in exports were balanced by years with increases in exports.

Reservoir Storage

In many years, modeling results showed storage in New Melones, New Don Pedro, and Lake McClure reservoirs was altered when compared to baseline. Reasons why reservoir storage changed include the following.

- Under the LSJR alternatives, the combination of higher river flows and demand for diversions sometimes resulted in lower carryover storage compared to baseline.
- The LSJR alternatives have minimum carryover storage guidelines to avoid adverse temperature impacts on fish and wildlife beneficial uses, and thus there were some dry years when the carryover storage was larger than under baseline conditions.
- The LSJR alternatives (particularly LSJR Alternatives 3 and 4) may retain water in the reservoirs beyond June for adaptive implementation purposes; this was modeled to occur during wet years and, for the Merced River, in above normal years.
- The LSJR alternatives caused variations in the frequency and timing of flood control releases (particularly for New Don Pedro Reservoir and Lake McClure).

Reservoir storage is of most concern during the fall when storage is at its lowest point. Table 5-22a shows average carryover storage (end of September) for each reservoir and alternative. The changes in average carryover storage were 13 percent or less. Under LSJR Alternative 2, all three reservoirs had an increase or no change in average carryover storage relative to baseline. Average carryover storage under LSJR Alternative 3 was less than for LSJR Alternative 2, and average carryover storage under LSJR Alternative 4 was less than for LSJR Alternative 3.

During critical years, LSJR alternative carryover storage was greater than baseline carryover storage under all LSJR alternatives for all reservoirs (Table 5-22b) because the carryover storage targets are part of the LSJR alternatives and not baseline. For both New Melones Reservoir and Lake McClure, the increase in critical-year carryover storage was substantial (47–113 percent)

Table 5-22a. Average Carryover Storage and Differences from Baseline in the Eastside Tributary Reservoirs for the LSJR Alternatives for the 82-Year Modeling Period

	New Melones TAF / (%)	New Don Pedro TAF / (%)	Lake McClure TAF / (%)
Baseline	1,125 / (100)	1,348 / (100)	453 / (100)
LSJR Alternative 2 Difference from Baseline	136/(12)	-6/ (0)	58/ (13)
LSJR Alternative 3 Difference from Baseline	63/ (6)	-99/ (-7)	26/ (6)
LSJR Alternative 4 Difference from Baseline	-38/ (-3)	-125/ (-9)	9/ (2)
TAF = thousand acre-feet			

Table 5-22b. Average Carryover Storage and Differences from Baseline in the Eastside Tributary Reservoirs for the LSJR Alternatives for Critical Years during the 82-Year Modeling Period

	New Melones TAF / (%)	New Don Pedro TAF / (%)	Lake McClure TAF / (%)
Baseline	540 / (100)	880 / (100)	154 / (100)
LSJR Alternative 2 Difference from Baseline	254/ (47)	65/ (7)	161/ (104)
LSJR Alternative 3 Difference from Baseline	290/ (54)	60/ (7)	174/ (113)
LSJR Alternative 4 Difference from Baseline	306/ (57)	88/ (10)	113/ (73)
TAF = thousand acre-feet			

Hydropower

The rim dams release water through the hydroelectric turbines at their maximum efficiency capacity in order to generate energy. Typically, water is released for a specified number of hours each day. The number of hours of releases is a function of daily average release flow and the turbine capacity flow.

Downstream of the rim dams are regulating reservoirs on each of the three eastside tributaries (e.g., McSwain Dam on the Merced River; the hydroelectric power plant at TID canal on the Tuolumne River; and Tulloch Dam on the Stanislaus River). These regulating reservoirs operate with a seasonal storage elevation and a daily fluctuating elevation that depends on the number of peaking hours to flatten the peaking from the hydropower facilities and release more steady flows downstream.

The normal peaking-energy operation of the rim dams would continue under the LSJR alternatives. The only changes to the peaking energy operation would be slightly different hours with peaking energy releases each day during the month according to the monthly changes in the simulated WSE model river flows and diversion flows under the LSJR alternatives.

Because hydropower generation is dependent on reservoir elevation (head), a reduction in storage has the potential to affect hydropower generation. In addition, there is the potential for hydropower generation to be reduced as a result of the extent to which reservoir releases exceed the capacity of the hydropower turbines. The economic value of hydropower generation is somewhat dependent on time of year, with a greater demand for electricity in the summer than in the winter and spring. The change in reservoir releases associated with the LSJR alternatives affects the distribution of power generation between these seasons.

Water Temperature

A summary of modeled water temperature results for baseline and under each LSJR alternative are presented below for each tributary (Tables 5-23a through 5-23c). These temperature results are fully described in Appendix F.1, *Hydrologic and Water Quality Modeling*.

Due to the dynamics of heat exchange, river temperatures generally increase if river flow is reduced and decrease if river flow is increased. A change in flow can cause a corresponding change in the water temperature downstream. However, if the existing flow is relatively high, a change in flow would likely cause a smaller change in temperature than would the same change in flow if the existing flows were lower. Furthermore, a change in flow during colder months causes a smaller change in water temperature than during warmer months. This is because during colder months the reservoir release temperatures are more similar to the average ambient air temperatures. Appendix F.1 provides more detail about the relationship between flow and water temperature.

Changes in relatively low flows during warm months are likely to have a substantial effect on water temperatures. The biggest changes in water temperature are expected to occur from April–June. The LSJR alternatives also affected water temperature from February–March, but to a lesser degree than during the warmer months.

Although the LSJR alternatives apply to February–June, there are several reasons why modeled results show water temperatures changing outside of this period. One reason temperatures could change relative to baseline from July–January is that there are occasionally changes in flow during these months due to reduced spills in wet years, and shifting of flows to the fall as a part of adaptive implementation (for more specific details regarding flow shifting, see Appendix F.1, Section F.1.2.7, *Calculation of River and Reservoir Water Balance*). Water temperatures also are affected by changes in reservoir storage, which could occur during any month, but low storage in the fall is of most concern because the cold water at the bottom of the reservoirs could be depleted in the fall. Appendix F.1 provides more detail about the relationship between reservoir storage and water temperature.

The average monthly temperatures were compared between baseline and the LSJR alternatives (Table 5-23a through 5-23c). This temperature evaluation was performed at a single location for each tributary: at RM 27.1 on the Merced River; at RM 28.1 on the Tuolumne River; and at RM 28.2 on the Stanislaus River (Appendix F.1). These are approximately the halfway points between the river mouths and the upstream regulating reservoirs and were selected because they are good locations for capturing the effect of flow on water temperature. Water temperature effects at Lake McClure, New Don Pedro Reservoir, and New Melones Reservoir releases are driven only by changes in the storage.

The 10th, 50th (median), and 90th percentiles show the general range of temperatures modeled for baseline conditions and the LSJR alternatives. Baseline temperatures are shown followed by the differences between the LSJR alternatives and baseline. The 90th percentile results present the warmest temperatures, which generally are of more concern to the harming of fish and wildlife than cooler temperatures.

At the halfway locations, the baseline January to July seasonal warming of median temperatures ranged from 27°F on the Merced River to 19°F on the Stanislaus and Tuolumne Rivers (Table 5-23a through 5-23c). The spread of temperatures for any given month (90th percentile minus 10th percentile) varies by month, with June or July generally having the largest spread. The largest spread occurred on the Tuolumne River (23°F in July).

On the Merced River (Table 5-23a), LSJR Alternatives 2, 3, and 4 produced progressively cooler water temperatures in many months, with the effect being largest in May or June. Median June temperatures were 6.0°F cooler for LSJR Alternative 2, 8.7°F cooler for LSJR Alternative 3, and 10.3°F cooler for LSJR Alternative 4. Temperature reductions for the June 90th percentile values were 5-6°F smaller than the reduction in median temperatures.

Similarly, on the Tuolumne River (Table 5-23b), LSJR Alternatives 2, 3, and 4 produced progressively cooler water temperatures in many months, with the effect being largest in June. However, temperature reductions in the Tuolumne River were larger than on the Merced or Stanislaus Rivers. Median June temperatures were 8.3°F cooler for LSJR Alternative 2, 11.4°F cooler for LSJR Alternative 3, and 12.5°F cooler for LSJR Alternative 4. Temperature reductions for the June 90th percentile values were 1-6°F smaller than the reductions in median temperatures.

On the Stanislaus River (Table 5-23c), temperature effects for LSJR Alternative 2 were relatively small, with some values being a little higher than baseline and some being a little lower. This is a reflection of the effect of LSJR Alternative 2 on Stanislaus River flows, the effect of which was relatively small and variable relative to baseline. On the Stanislaus River, LSJR Alternatives 3 and 4 produced cooler water temperatures in many months, but the effect was smaller than on the

Tuolumne or Merced Rivers. Median June temperatures were 1.1°F cooler for LSJR Alternative 3 and 3.0°F cooler for LSJR Alternative 4.

Table 5-23a. Monthly Cumulative Distributions of Simulated Merced River Water Temperatures (Fahrenheit) at River Mile 27.1 for Baseline and Differences from Baseline for the LSJR Alternatives for 1970–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Baseline												
10	60.9	55.1	49.7	48.6	50.2	51.2	56.4	57.9	56.4	60.3	63.8	64.1
50	62.6	57.1	51.2	50.0	52.9	57.1	61.9	66.4	73.9	76.7	75.4	72.1
90	68.6	61.1	53.4	52.3	55.5	59.9	65.8	70.9	76.1	80.1	79.0	76.8
LSJR Alternative 2 Minus Baseline												
10	-0.4	0.0	0.0	0.0	-0.3	-0.2	-0.1	-0.5	0.4	0.0	0.0	0.1
50	0.0	-0.1	0.0	0.3	0.5	0.4	-0.7	-4.2	-6.0	-0.4	0.0	-0.3
90	-2.9	-1.9	-0.4	0.0	0.2	0.2	-2.3	-3.7	-1.4	-0.8	-0.4	-0.2
LSJR Alternative 3 Minus Baseline												
10	-1.1	0.1	0.1	0.0	-0.7	-0.1	-0.5	-1.8	0.9	0.1	0.1	-0.1
50	-0.6	-0.4	0.0	0.2	0.1	-0.5	-3.1	-6.8	-8.7	-1.0	-0.3	-0.7
90	-2.7	-1.9	-0.5	0.0	-0.1	-0.9	-4.7	-6.4	-3.6	-1.0	-0.3	-0.1
LSJR Alternative 4 Minus Baseline												
10	-0.5	0.4	0.0	-0.1	-1.5	-0.3	-3.0	-3.3	1.2	5.5	1.4	0.3
50	-0.5	-0.5	0.2	0.1	0.2	-1.5	-4.5	-8.4	-10.3	-1.1	-0.1	-0.4
90	-1.5	-1.3	-0.4	0.0	-0.4	-1.5	-5.7	-7.5	-4.6	-0.8	0.0	0.1

Table 5-23b. Monthly Cumulative Distributions of Simulated Tuolumne River Water Temperatures (Fahrenheit) at River Mile 28.1 for Baseline and Differences from Baseline for the LSJR Alternatives for 1970–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Baseline												
10	58.1	54.2	50.5	49.7	49.4	49.6	51.0	52.2	54.0	56.5	67.7	63.2
50	60.5	55.4	51.5	51.4	53.6	52.5	54.0	56.3	68.2	70.8	70.3	67.2
90	65.8	57.8	53.4	53.0	56.5	60.9	61.5	63.8	75.5	79.2	77.8	74.5
LSJR Alternative 2 Minus Baseline												
10	0.2	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	0.0
50	0.1	0.1	0.0	0.2	-0.6	0.2	0.0	-0.2	-8.3	-0.5	0.0	0.1
90	-0.3	-0.2	-0.2	0.0	-0.1	-2.1	-2.8	-1.3	-2.4	-1.1	0.0	0.0
LSJR Alternative 3 Minus Baseline												
10	-0.9	0.3	-0.1	0.2	-0.1	0.0	-0.1	-0.1	0.0	0.5	-1.7	-3.3
50	-0.4	0.0	0.4	0.2	-1.2	-0.5	-0.4	-2.6	-11.4	-0.7	-0.3	0.3
90	-0.2	-0.4	-0.1	0.1	-1.6	-4.9	-6.1	-6.4	-8.9	-1.5	0.0	0.0
LSJR Alternative 4 Minus Baseline												
10	-0.3	0.6	-0.3	0.0	-0.1	0.0	-0.4	-0.2	-0.3	3.8	-1.5	-2.6
50	-0.5	0.4	0.4	0.2	-1.9	-0.9	-1.2	-2.9	-12.5	-0.7	-0.1	0.5
90	-0.2	-0.5	0.0	0.2	-2.1	-6.3	-7.2	-7.9	-11.6	-1.7	0.0	0.0

Table 5-23c. Monthly Cumulative Distributions of Simulated Stanislaus River Water Temperatures (Fahrenheit) at River Mile 28.2 for Baseline and Differences from Baseline for the LSJR Alternatives for 1970–2003

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Baseline												
10	55.6	53.6	48.6	47.2	49.5	51.0	52.7	54.7	57.8	64.7	64.5	61.1
50	57.4	55.0	50.5	49.3	51.2	54.7	55.1	57.1	62.3	68.7	68.5	65.6
90	65.3	57.5	51.7	50.9	53.8	57.3	59.4	62.1	69.4	73.0	72.8	70.8
LSJR Alternative 2 Minus Baseline												
10	0.0	0.0	0.0	0.1	-0.2	0.0	0.4	0.3	-0.2	1.4	1.1	1.1
50	-0.1	-0.5	-0.3	0.0	-0.3	-0.9	0.0	0.1	0.8	-0.1	-0.5	-0.1
90	-4.5	-0.6	-0.3	-0.2	-0.6	0.6	-0.6	-0.8	-0.5	-0.3	-0.7	-1.4
LSJR Alternative 3 Minus Baseline												
10	-0.2	0.0	0.1	0.0	-1.0	0.1	0.3	0.0	-1.0	-1.9	1.2	-0.4
50	-0.1	-0.1	-0.3	0.0	-0.6	-1.9	-0.1	-0.3	-1.1	-0.5	-0.6	-0.7
90	-5.4	-0.6	-0.2	-0.2	-0.9	-0.8	-1.4	-1.6	-0.7	-0.4	-0.6	-1.3
LSJR Alternative 4 Minus Baseline												
10	0.0	0.1	0.2	-0.2	-1.2	-0.4	0.1	-1.0	-2.6	-2.3	0.5	-0.1
50	0.2	-0.1	-0.3	0.1	-1.2	-2.0	-0.4	-1.2	-3.0	-0.1	-0.1	0.0
90	-5.4	-0.4	-0.1	-0.2	-1.4	-1.8	-2.7	-2.2	-1.4	-0.3	-0.5	-1.3

5.4.3 Impacts and Mitigation Measures

Impact WQ-1: Violate water quality standards by increasing the number of months with EC above the water quality objectives for salinity at Vernalis or southern Delta compliance stations

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

The impact associated with each LSJR alternative was assessed using the existing water quality objectives. The impact WQ-1 analysis focuses on the objectives at the southern Delta compliance stations because these objectives are the most likely to be exceeded as a result of changes in LSJR flows. Water quality at locations farther downstream is less affected by changes in LSJR flow and is more likely to be affected by the presence of relatively clean water from the Sacramento River.

The monthly EC values at Vernalis, corresponding to the monthly flows and assumed LSJR salt loads, were calculated for the 1922–2003 time period with the WSE model. The modeling incorporated additional releases from New Melones Reservoir in some months to satisfy the baseline Vernalis EC objectives because USBR is required to maintain salinity at Vernalis in accordance with its water rights. Under the LSJR alternatives, the Vernalis objectives would be the same as the baseline objectives. Under the SDWQ alternatives, the Vernalis objectives would change, but the program of implementation would still require that USBR ensure the Vernalis EC values remain less than or equal to 0.700 dS/m for April–August and 1.000 dS/m for September–March as a 30-day running average.

The number of months when the estimated EC at the southern Delta compliance stations would exceed the existing water quality objectives for each LSJR alternative was compared to the number of months that the estimated EC would exceed the existing water quality objectives under baseline flow and EC conditions. The impact associated with each SDWQ alternative was assessed by evaluating how the number of months with EC greater than the objectives would change in response to the change in objectives under the SDWQ alternatives. The number of months the EC exceeded the existing EC objective was compared to the number of months the EC exceeded the objectives for each of the SDWQ alternatives.

Described below are baseline conditions at the Vernalis and the southern Delta compliance stations. Note that the baseline EC values described here are different from the historic measured EC values described in the environmental setting section above; the baseline values cover a longer period of record as simulated by the WSE model and they represent recent operating procedures unlike the historic values, which represent variable regulations for system operations. The baseline EC values are a better representation of EC under existing regulations than the historical EC values. The calculated monthly EC values for the SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy

Boulevard for baseline are given in Appendix F.1, *Hydrologic and Water Quality Modeling,* (Tables F.1-14b, e, and g).

Table 5-24a shows a summary of monthly Vernalis EC values for baseline as simulated with the WSE model for 1922–2003, sorted by the number of years with values greater than 0.400–1.200 dS/m (400 µS/cm–1,200 µS/cm) in 0.100 dS/m (100 µS/cm) increments.[15] The table indicates the number of years with a calculated monthly EC value greater than the EC values given in the first column. For example, the Vernalis EC values in October for baseline were above 0.400 dS/m (400 µS/cm) in 78 years (out of 82 years); above 0.500 dS/m (500 µS/cm) in 36 years; and above 0.600 dS/m (600 µS/cm) in 0 years. Other months with an EC objective of 1.000 dS/m (1,000 µS/cm) show no violations at Vernalis. There were 20 years with an EC of greater than 0.900 dS/m (900 µS/cm) in February and 16 years with a March EC of greater than 0.900 dS/m (900 µS/cm), suggesting that the EC values for baseline were often approaching the EC objective in these months. Many of the simulated Vernalis EC values in April–August were above 0.600 dS/m (600 µS/cm), suggesting that EC was approaching the EC objectives in many years during this period.

Table 5-24a. Monthly Distribution of SJR at Vernalis EC Values (100 µS/cm increments) for Baseline for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	78	80	79	73	62	51	45	39	66	78	77	79	77
500	36	75	78	69	56	47	28	21	43	69	57	55	56
600	0	46	74	64	49	43	15	12	22	40	21	7	34
700	0	5	67	54	37	28	0	0	0	0	0	0	13
800	0	0	54	23	31	22	0	0	0	0	0	0	0
900	0	0	3	0	20	16	0	0	0	0	0	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-24b shows the baseline monthly distribution of calculated EC values at Brandt Bridge. There were 16 years in February and 15 years in March that exceeded the 1.000 dS/m (1,000 µS/cm) objective (a total of 31 months out of 574). There were 12 years in April, 8 years in May, 17 years in June, 26 years in July, and 16 years in August that exceeded the 0.700 dS/m (700 µS/cm) objective (a total of 79 months out of 410). The baseline EC values at Brandt Bridge exceeded the EC objectives in a total of 110 months out of the 984 months from 1922–2003.

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[15] These EC objective values have a line under them in the table; the number of months with calculated EC above the EC objective is in this row.

Table 5-24b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 µS/cm increments) for Baseline for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	80	80	79	73	62	52	47	40	67	78	79	79	80
500	68	77	78	72	57	48	30	25	48	69	62	70	62
600	8	62	76	65	52	44	19	18	39	63	48	30	46
700	0	25	69	56	43	30	12	8	17	26	16	4	20
800	0	2	61	47	34	26	0	0	3	4	4	0	9
900	0	0	19	10	26	17	0	0	0	0	0	0	0
1,000	0	0	0	0	16	15	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-24c shows the baseline monthly distribution of calculated EC in Old River at Tracy Boulevard. There was a total of 81 months with EC values higher than the EC objective of 1.000 dS/m (1,000 µS/cm) (September–March) and a total of 186 months with EC values higher than the EC objective of 0.700 dS/m (700 µS/cm) (April–August). The baseline EC values at Tracy Boulevard exceeded the existing EC objectives in a total of 267 months (out of 984), approximately 27 percent of the months in the 82-year modeled simulation. This percent of time with exceedances is greater than the percent of time of measured EC exceedances reported at Old River at Tracy during the past 25 years.[16]

Table 5-24c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 µS/cm Increments) for Baseline for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	80	80	79	74	62	55	57	58	71	78	79	79	81
500	75	79	78	72	57	50	38	36	60	73	77	79	73
600	50	77	76	66	55	46	26	21	44	67	60	63	56
700	8	61	72	63	46	43	18	17	39	61	51	32	43
800	1	27	67	55	36	29	12	9	22	39	26	8	20
900	0	5	59	44	33	26	5	3	13	19	10	4	12
1,000	0	1	24	16	24	16	0	0	6	7	7	0	2
1,100	0	0	5	2	16	15	0	0	0	3	3	0	0
1,200	0	0	0	0	0	6	0	0	0	2	1	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

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[16] The values predicted by the modeled simulation are more than the actual measured data because the method used to calculate the EC increment between Vernalis and Old River at Tracy Boulevard provides a conservative estimate of the effect of any potential decreases in flow at Vernalis on the EC increment (Appendix F.1, *Hydrologic and Water Quality Modeling*).

Table 5-25 summarizes the number of months with EC higher than the objectives at the two representative compliance stations for baseline and for each LSJR alternative. As described in Section 5.2.7, *Southern Delta*, Union Island (Old River near Middle River) has EC similar to Brandt Bridge. The number of months with EC higher than the objectives would be reduced for SDWQ Alternatives 2 and 3.

Table 5-25. Number of Months when Estimated EC Values would be Greater than EC Objectives at Southern Delta Compliance Stations 1922–2003 (984 months)

Compliance Station	Baseline	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Baseline EC Objectives (700 µS/cm April–August and 1,000 µS/cm September–March)				
Brandt Bridge	110	93	74	68
Tracy Boulevard	267	248	202	196
SDWQ Alternative 2 (1,000 µS/cm January–December)				
Brandt Bridge	31	40	28	17
Tracy Boulevard	101	107	95	86
SDWQ Alternative 3 (1,400 µS/cm January–December)				
Brandt Bridge	0	0	0	0
Tracy Boulevard	0	0	0	0

Note: The WSE modeling includes releases of additional water from New Melones Reservoir necessary to meet the existing Vernalis EC objectives of 0.700 dS/m (700 µS/cm) for April–August and 1.000 dS/m (1000 µS/cm) for September–March, which would be required as part of the program of implementation.

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)

µS/cm = microSiemens per centimeter

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

The calculated monthly EC values for the SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard for LSJR Alternative 2 are given in Appendix F.1, *Hydrologic and Water Quality Modeling* (Tables F.1-15a through 15c). Table 5-26a shows the monthly Vernalis EC values for LSJR Alternative 2. There were no months with EC values greater than the objectives at Vernalis because the WSE modeling for the LSJR alternatives included the requirement from the program of implementation that USBR continue to meet the existing Vernalis EC objectives by releasing water from the New Melones Reservoir.

Table 5-26b shows that Brandt Bridge EC values for LSJR Alternative 2 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 40 months (out of 574 months) and were higher than the 0.700 (700 µS/cm) objective in the months of April–August in a total of 53 months (out of 410 months), for a total of 93 exceedances of the existing objectives. The EC was higher than the EC objective for LSJR Alternative 2 in 17 months fewer than for baseline because some of the estimated Vernalis flows were higher compared to baseline, and the corresponding Vernalis EC values were slightly lower. The calculated EC values in Old River at Middle River (Union Island) are assumed to be the same as at Brandt Bridge. Because of the overall reduced incidence of EC values that would be above the EC objective (93 months for LSJR Alternative 2 versus 110 months for baseline), impacts would be less than significant at Brandt Bridge and Union Island.

Table 5-26a. Monthly Distribution of SJR at Vernalis EC Values (100 µS/cm increments) for LSJR Alternative 2 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	78	80	79	73	61	53	48	26	44	77	75	76	76
500	34	74	78	68	56	47	22	9	21	70	57	56	54
600	0	46	75	64	46	42	7	2	5	42	19	6	32
700	0	5	70	57	37	33	0	0	0	0	0	0	5
800	0	0	56	26	35	29	0	0	0	0	0	0	0
900	0	0	3	0	29	20	0	0	0	0	0	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-26b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 µS/cm increments) for LSJR Alternative 2 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	80	80	79	73	61	53	51	31	52	77	77	76	79
500	67	77	78	71	58	48	32	12	25	70	63	69	64
600	8	60	78	64	48	43	15	5	16	65	47	27	47
700	0	25	71	59	38	34	5	2	4	27	15	4	18
800	0	2	64	48	36	30	0	0	0	4	4	0	2
900	0	0	19	10	33	23	0	0	0	0	0	0	0
1,000	0	0	0	0	22	18	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-26c shows that the Old River at Tracy Boulevard EC values for LSJR Alternative 2 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 95 months and were higher than the 0.700 (700 µS/cm) objective in the months of April–August in a total of 153 months (out of 410 months), for a total of 248 exceedances of the existing objectives. Because of the reduced incidence of EC values that were above the EC objective at Tracy Boulevard (248 months for LSJR Alternative 2 versus 267 months for baseline), impacts would be less than significant at Tracy Boulevard.

Table 5-26c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 µS/cm increments) for LSJR Alternative 2 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	80	80	79	74	61	54	58	40	62	78	77	79	80
500	75	79	78	71	59	51	42	25	42	73	75	76	73
600	46	76	78	65	55	44	23	10	24	68	61	64	53
700	8	59	72	63	43	42	13	6	18	65	51	29	41
800	1	27	70	56	37	33	5	2	9	40	25	7	23
900	0	5	61	46	35	30	2	1	3	18	10	4	8
1,000	0	1	24	16	31	23	0	0	0	6	6	0	0
1,100	0	0	5	2	21	18	0	0	0	3	3	0	0
1,200	0	0	0	0	0	6	0	0	0	2	1	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. Under LSJR Alternative 2, this adaptive implementation approach would increase flows in the three eastside tributaries. As a result, it is anticipated the EC values presented above for SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard would not be substantially different or would actually be reduced because any additional flow in the LSJR potentially required under adaptive implementation would likely result in a decrease in EC in the southern Delta and at compliance points because increases in flow from the relatively low salinity eastside tributaries would dilute salt load. Therefore, method 1 would not result in an increase in EC.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June time frame. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. During February–June, method 2 could potentially cause temporary increases in EC associated with flow dropping below 20 percent of the unimpaired flow, but increases in EC would be limited by the salinity requirements for Vernalis as specified in the program of implementation and would be offset by reductions in EC associated with flow increasing above 20 percent unimpaired flow at other times during February–June. Although changes in the timing of flows released from February–June under adaptive implementation method 2 would cause flow to temporarily go below 20 percent of the unimpaired flow, EC at Vernalis would still be maintained at or below a running 30-day average of 0.7 dS/m April–August and 1.0 dS/m September–March through the program of implementation, as it is under the current objectives and, furthermore, flows would not be permitted to go below what is required by other agencies and processes. As such, it is unlikely that there would be more exceedances than would occur under baseline. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent; therefore, method 3 would not affect EC.

Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. WSE model results show that under LSJR Alternative 2 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 2.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required 0.7 percent of the time to meet a 1,000-cfs requirement and 0.5 percent of the time for an 800-cfs Vernalis base flow requirement. These results indicate that changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR.

Impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3. With method 1, if the specified percent of unimpaired flow were changed from 20 percent to 30 percent on a long-term basis, the conditions and impacts could become more similar to those described under LSJR Alternative 3. It is anticipated that over time the unimpaired flow requirement could increase or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. If method 2 is implemented, the total annual volume of water associated with LJSR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change, but the timing or magnitude of flows might change. Implementing method 4 would have little effect on conditions in the three eastside tributary rivers and LSJR because it rarely would cause a change in flow and the volume of water involved would be relatively small. As described above, adaptive implementation method 1 could cause a reduction in EC and methods 2 and 4 would cause little to no change in EC. Consequently, adaptive implementation would not affect the impact determination for the potential effect of LSJR Alternative 2 on attainment of EC objectives at Vernalis and southern Delta compliance locations, and impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

The calculated monthly EC values for the SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard for LSJR Alternative 3 are given in Appendix F.1, *Hydrologic and Water Quality Modeling,* (Tables F.1-16a through 16c). Table 5-27a shows the monthly Vernalis EC values for LSJR Alternative 3, with adjusted Stanislaus River flows to meet the Vernalis EC objectives. There were no months with EC violations at Vernalis. Table 5-27b shows that Brandt Bridge EC values for LSJR Alternative 3 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 28 months. The Brandt Bridge EC values were higher than the EC objective of 0.700 dS/m (700 µS/cm) in a total of 46 months during the April–August period. In total, at Brandt Bridge there were fewer months with EC values greater than the objective under

LSJR Alternative 3 than there were for baseline (74 months for LSJR Alternative 3 versus 110 months for baseline). As described in Section 5.2.7, *Southern Delta*, Union Island (Old River near Middle River) has EC similar to Brandt Bridge.

Table 5-27a. Monthly Distribution of SJR at Vernalis EC Values (100 µS/cm increments) for LSJR Alternative 3 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	59	76	78	76	64	54	21	2	19	77	77	60	77
500	15	57	78	72	49	43	5	1	6	66	60	50	51
600	0	45	78	72	43	35	1	0	4	38	22	6	17
700	0	6	77	63	42	23	0	0	0	0	0	0	1
800	0	0	63	31	32	13	0	0	0	0	0	0	0
900	0	0	8	2	23	9	0	0	0	0	0	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-27b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 µS/cm increments) for LSJR Alternative 3 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	63	79	79	76	65	56	28	5	29	77	80	69	79
500	42	58	78	72	50	47	8	1	11	68	63	57	58
600	0	55	78	72	44	39	2	1	4	60	46	30	32
700	0	26	77	65	43	25	1	0	3	27	15	4	4
800	0	3	72	56	38	17	0	0	0	4	4	0	0
900	0	0	25	13	25	11	0	0	0	0	0	0	0
1,000	0	0	4	0	16	8	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-27c shows that the Old River at Tracy Boulevard EC values for LSJR Alternative 3 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 83 months.[17] The Tracy Boulevard calculated EC values for LSJR Alternative 3 were higher than the EC objective of 0.700 dS/m (700 µS/cm) in a total of 119 months during the April–August period. The total number of months with EC values above the EC objective for Old River at Tracy Boulevard would be reduced compared to baseline (202 months for LSJR Alternative 3 versus 267 months for baseline). Because LSJR Alternative 3 would likely reduce the number of months with EC above the existing EC objectives at Brandt Bridge, Union Island, and Tracy Boulevard, impacts would be less than significant.

Table 5-27c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 µS/cm increments) for LSJR Alternative 3 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	80	80	79	76	66	61	38	10	34	78	80	79	79
500	57	73	78	72	56	49	16	2	24	72	77	58	69
600	24	58	78	72	45	42	5	1	10	64	62	56	51
700	3	55	77	69	43	34	2	1	5	60	51	33	27
800	0	28	77	63	42	23	1	0	4	38	25	8	10
900	0	6	69	53	35	15	1	0	2	19	11	4	1
1,000	0	1	29	18	24	11	0	0	0	6	6	0	0
1,100	0	0	8	2	16	8	0	0	0	3	3	0	0
1,200	0	0	0	0	0	3	0	0	0	2	1	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Adaptive Implementation

Under LSJR Alternative 3, impacts associated with adaptive implementation method 1 may be slightly different from those associated with adaptive implementation methods 2 and 3.

Implementing method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40-percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent). Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. Adaptive implementation method 1 could affect the amount of water available for water supply and the volume of water and level of flow in the LSJR and its tributaries. However, the frequency and duration of such a change is unknown. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively. It is anticipated that over time the unimpaired flow requirement could increase, decrease, or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. If February–June flow is reduced as a

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[17] As described above, the calculated EC values in Old River at Tracy Boulevard are generally greater than the EC values measured during the past 25 years.

result of adaptive implementation method 1, the reduction could cause an increase in EC relative to LSJR Alternative 3 without adaptive implementation. However, flow would not be reduced below 30 percent of unimpaired flow. Because LSJR Alternative 2 at 20 percent of unimpaired flow would not significantly impact the attainment of EC objectives in the southern Delta, 30 percent of unimpaired flow, as allowed by adaptive implementation method 1, would also not significantly impact the attainment of EC objectives.

Under adaptive implementation methods 2 or 3, the overall volume of water from the February–June time period or after June would be the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. These two methods would not allow flows to go below what is required by existing requirements on the three tributaries and the SJR. EC, which can be dependent on the timing or magnitude of flow, could potentially be affected by method 2 or 3. Under adaptive implementation methods 2 or 3, flows could temporarily be reduced and EC increased in comparison to the 40 percent unimpaired flows. However, flows would be unlikely to go below baseline flows and flow reductions would be offset by increases in flows during other months.

Implementing method 4 would have little effect on conditions in the three eastside tributary rivers. WSE model results show that under Alternative 3 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 1.2 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required only 0.2 percent of the time to meet either a 1,000-cfs or 800-cfs Vernalis base flow requirement. These results indicate that method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative and, thus, would not influence EC.

Because adaptive implementation method 1 would not allow flows to go below those of LSJR Alternative 2 and because increases in EC resulting from methods 2–4 would cause little to no change in EC, adaptive implementation would not affect the impact determination for the effect of LSJR Alternative 3 on attainment of EC objectives at Vernalis and southern Delta compliance locations. Impacts would remain less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Table 5-28a shows the monthly Vernalis EC values for LSJR Alternative 4, with adjusted Stanislaus River flows to meet the Vernalis EC objectives. There were no months with EC violations at Vernalis. Table 5-28b shows that Brandt Bridge, EC values for LSJR Alternative 4 were higher than the 1.000 dS/m (1,000 μS/cm) objective in the months of September–March in a total of 17 months. The Brandt Bridge EC values were higher than the EC objective of 0.700 dS/cm (700 μS/cm) in a total of 51 months during the April–August period. In total, there were fewer months with Brandt Bridge and Union Island EC values greater than the EC objective under LSJR Alternative 4 (68 months for LSJR Alternative 4 versus 110 months for baseline).

Table 5-28a. Monthly Distribution of SJR at Vernalis EC Values (100 µS/cm increments) for LSJR Alternative 4 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	59	75	79	75	54	46	6	1	6	77	77	60	76
500	15	57	79	73	45	30	2	0	4	72	63	50	42
600	0	45	77	72	40	17	0	0	1	52	22	6	5
700	0	6	77	66	29	11	0	0	0	0	0	0	0
800	0	0	64	35	24	8	0	0	0	0	0	0	0
900	0	0	8	4	14	3	0	0	0	0	0	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-28b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 µS/cm increments) for LSJR Alternative 4 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	63	79	79	75	56	48	7	1	9	77	80	69	79
500	43	58	79	73	45	32	2	0	5	74	71	57	55
600	0	55	79	72	41	21	1	0	3	69	47	31	17
700	0	26	77	67	31	13	0	0	1	35	15	4	3
800	0	3	73	59	27	9	0	0	0	4	4	0	0
900	0	0	25	17	16	6	0	0	0	0	0	0	0
1,000	0	0	4	2	9	2	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-28c shows that the Old River at Tracy Boulevard EC values for LSJR Alternative 4 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 74 months. The Tracy Boulevard calculated EC values were higher than the EC objective of 0.700 dS/m (700 µS/cm) in a total of 122 months during the April–August period. The total incidence of monthly EC values that were above the EC objective at Tracy Boulevard would be reduced compared to baseline (196 months for LSJR Alternative 4 versus 267 months for baseline). Because LSJR Alternative 4 would likely reduce the number of months with EC values above the EC objectives at Brandt Bridge, Union Island, and Tracy Boulevard, impacts would be less than significant.

Table 5-28c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 µS/cm increments) for LSJR Alternative 4 for 1922–2003

EC Value	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
400	80	80	79	75	62	54	14	2	13	79	80	80	79
500	57	70	79	75	47	41	4	1	9	77	77	58	70
600	24	58	79	72	44	29	2	0	6	71	70	56	46
700	3	55	77	70	36	16	1	0	3	68	50	35	17
800	0	28	77	66	29	12	0	0	2	39	28	8	4
900	0	6	71	57	25	8	0	0	1	19	11	4	1
1,000	0	1	30	21	16	6	0	0	0	6	6	0	0
1,100	0	0	8	2	10	2	0	0	0	3	3	0	0
1,200	0	0	0	0	0	1	0	0	0	2	1	0	0

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Adaptive Implementation

As discussed under LSJR Alternatives 2 and 3, adaptive implementation methods 2, 3, and 4 would not result in substantial increases in EC. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the February–June, 60-percent unimpaired flow requirement (to 50 percent). Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3, with adaptive implementation. Because LSJR Alternative 3 would have a less-than-significant effect on attainment of EC objectives, the impact of LSJR Alternative 4 with adaptive implementation would also be less than significant.

SDWQ Alternatives

SDWQ Alternative 2 (Less than significant)

Under SDWQ Alternative 2, the Vernalis and southern Delta salinity objectives would be changed to a year-round value of 1.0 dS/m. However, EC at Vernalis would be maintained at or below 0.7 dS/m April – August and 1.0 dS/m September–March through the program of implementation, as it is under the current objectives. This would provide some assimilative capacity downstream of Vernalis and protect beneficial agricultural uses. Because EC at Vernalis would be maintained under the program of implementation, as it is under the current objectives, SDWQ Alternative 2 would not change the Vernalis flow or EC values, regardless of whether the baseline flows or one of the LSJR alternatives were selected and implemented. SDWQ Alternative 2 would not lead to a deterioration of water quality at either Vernalis or the southern Delta.

The number of months with calculated EC values above the SDWQ Alternative 2 EC objective (1.0 dS/m in all months) would be different because most EC violations in the months of April–August at Brandt Bridge and Tracy Boulevard would be eliminated with the higher EC objective, but the calculated number of months with EC violations in the months of September–March would remain the same (because the EC objective would be the same). SDWQ Alternative 2 would generally reduce the number of months with EC values above the existing EC objectives (baseline) for the baseline flows and all LSJR alternatives (flows) in the following manner and as shown in Table 5-25.

- If SDWQ Alternative 2 is adopted, the number of calculated EC exceedances at Brandt Bridge would decrease from 110 months (out of 984) to 31 months if the flow and EC at Vernalis remain at baseline levels. The number of calculated EC violations at Tracy Boulevard would decrease from 267 months to 101 months. This reduces the incidence of EC values that were above the EC objective when compared to baseline.
- If LSJR Alternative 2 is implemented and SDWQ Alternative 2 is adopted, the number of EC violations at Brandt Bridge would decrease from a baseline of 110 months to 40 months. The Tracy Boulevard EC exceedance would decrease from 267 to 107.
- If LSJR Alternative 3 is implemented and SDWQ Alternative 2 is adopted, the number of EC violations at Brandt Bridge would decrease from a baseline of 110 months to 28 months. The number of EC violations at Tracy Boulevard would decrease from 267 months for existing EC objectives to 95 months with SDWQ Alternative 2.
- If LSJR Alternative 4 is implemented and SDWQ Alternative 2 is adopted, the number of EC violations at Brandt Bridge would decrease from a baseline of 110 months to 17 months. The number of EC violations at Tracy Boulevard would decrease from 267 months to 86 months.

Under SDWQ Alternative 2, the water quality objectives would be met in more months when compared to baseline conditions. Impacts would be less than significant.

SDWQ Alternative 3 (Less than significant)

Under SDWQ Alternative 3, the Vernalis and southern Delta salinity objectives would be changed to a year-round value of 1.4 dS/m. However, EC at Vernalis would be maintained at or below 0.7 dS/m April–August and 1.0 dS/m September–March through the program of implementation, as it is under the current objectives. This would provide some assimilative capacity downstream of Vernalis and protect beneficial agricultural uses.

SDWQ Alternative 3 would not change the Vernalis flow or EC values, regardless of whether the baseline flows or one of the LSJR alternatives were selected and implemented. The number of months with calculated EC values above the SDWQ Alternative 3 EC objectives (1.4 dS/m in all months) would be reduced to 0 months because there are no calculated EC values of greater than 1.4 dS/m for baseline or for any of the LSJR alternatives. The reduced incidence of EC values that were above the EC objective is considered beneficial, and because there has never been a calculated EC value greater than 1.4 dS/m for the southern Delta, impacts would be less than significant.

Impact WQ-2: Substantially degrade water quality by increasing Vernalis or southern Delta EC such that agricultural beneficial uses are impaired

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the*

No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1), for the No Project Alternative technical analysis.

LSJR Alternatives

The EC objectives are established to protect the beneficial use for agricultural water supply. The calculated monthly EC values were used to evaluate possible degradation of water quality through a substantial increase in salinity for agricultural beneficial uses at Vernalis or in the southern Delta channels when compared to baseline conditions. The approach for determining whether the LSJR alternatives could lead to an overall impact of increased salinity considers the long term cumulative distribution for EC during the irrigation season (April–September[18]).

The baseline monthly cumulative distributions of EC values at SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard are given in Appendix F.1, *Hydrologic and Water Quality Modeling,* (Tables F.1-14b, e, and g). The monthly cumulative distributions of EC values at SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard for the LSJR alternatives are also given in Appendix F.1 (Tables F.1-15a through 15c for LSJR Alternative 2, Tables F.1-16a through 16c for LSJR Alternative 3, and Tables F.1-17a through 17c for LSJR Alternative 4). The average April–September EC values for baseline at Vernalis ranged from 198 μS/cm to 678 μS/cm, with an average of 497 μS/cm. The calculated April–September average EC values for baseline at Brandt Bridge ranged from 205 μS/cm to 791 μS/cm, with an average of 545 μS/cm (48 μS/cm higher than Vernalis EC). The calculated April–September average EC values for baseline at Tracy Boulevard ranged from 218 μS/cm to 1,038 μS/cm, with an average of 640 μS/cm (143 μS/cm higher than Vernalis EC).

Tables 5-29a through 5-29c show the average April-September EC values expected under LSJR Alternatives 2, 3, and 4.

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[18] September is included in the analysis because most agriculture still needs irrigation due to high air temperatures, high solar radiation, and little to no rain.

Table 5-29a. Cumulative Distributions of April–September Average EC values at Vernalis Baseline and LSJR Alternatives for 1922–2003

Percentile	Baseline	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Results	Change	Results	Change	Results	Change
April–September Average EC (µS/cm) at Vernalis for Baseline and LSJR Alternatives							
Minimum	198	198	0	200	2	217	19
10	346	345	-2	324	-22	327	-19
20	434	422	-12	376	-57	353	-81
30	448	443	-4	392	-56	365	-83
40	469	458	-11	404	-65	376	-93
50	503	480	-23	418	-85	384	-119
60	529	496	-33	434	-95	400	-129
70	543	518	-25	456	-87	416	-127
80	599	537	-62	471	-128	430	-168
90	640	564	-77	491	-149	452	-188
Maximum	678	658	-20	608	-70	545	-133
Average	497	471	-25	418	-78	389	-108

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-29b. Cumulative Distributions of April–September Average EC values at Brandt Bridge for Baseline and LSJR Alternatives for 1922–2003

Percentile	Baseline	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Results	Change	Results	Change	Results	Change
April–September Average EC (µS/cm) at Brandt Bridge for Baseline and LSJR Alternatives							
Minimum	205	205	0	206	2	224	20
10	364	362	-2	340	-24	345	-19
20	460	453	-7	397	-64	374	-86
30	484	477	-7	424	-60	392	-92
40	505	493	-12	441	-64	409	-96
50	548	524	-24	455	-93	418	-130
60	581	547	-34	474	-107	437	-144
70	595	571	-23	505	-89	460	-135
80	665	601	-64	525	-140	478	-187
90	736	656	-79	568	-167	518	-217
Maximum	791	755	-36	713	-78	641	-150
Average	545	516	-28	459	-86	427	-117

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

Table 5-29c. Cumulative Distributions of April–September Average EC values at Old River at Tracy Boulevard for Baseline and LSJR Alternatives for 1922–2003

Percentile	Baseline	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Results	Change	Results	Change	Results	Change
April–September Average EC (µS/cm) at Tracy Boulevard for Baseline and LSJR Alternatives							
Minimum	218	218	0	220	2	239	21
10	400	398	-2	373	-27	383	-17
20	513	514	1	445	-68	423	-90
30	555	542	-14	476	-79	445	-110
40	580	570	-10	510	-70	474	-106
50	630	605	-25	530	-99	491	-139
60	677	646	-31	561	-116	521	-156
70	707	680	-27	598	-109	544	-163
80	794	720	-74	632	-162	573	-221
90	907	814	-92	710	-197	650	-257
Maximum	1,038	977	-62	923	-116	833	-205
Average	640	607	-34	540	-100	504	-137

1000 µS/cm = 1 deciSiemen per meter (1 dS/m)
µS/cm = microSiemens per centimeter

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Table 5-29a indicates that the average April–September EC values at Vernalis ranged from 0.198 dS/m (198 µS/cm) to 0.658 dS/m (658 µS/cm), with an average of 0.471 dS/m (471 µS/cm) under LSJR Alternative 2. The decrease in the distribution of EC at Vernalis was greater at the higher EC values, with an average reduction of 0.025 dS/m (25 µS/cm). This slight decrease in Vernalis EC was caused by the general increase in the monthly flows compared to the baseline flows at Vernalis. Because the baseline EC objectives at Vernalis are also expected to be met under the LSJR alternatives (due to the continuing responsibility of USBR to meet Delta water quality objectives identified in their water rights), the maximum EC values at Vernalis did not increase above the objectives under LSJR Alternative 2.

Table 5-29b indicates that the average April–September EC values at Brandt Bridge ranged from 0.205 dS/m (205 µS/cm) to 0.755 dS/m (755 µS/cm), with an average EC of 0.516 dS/m (516 µS/cm) under LSJR Alternative 2. The decrease in the distribution of EC at Brandt Bridge relative to baseline was greater at the higher EC values, with an average reduction of 0.028 dS/m (28 µS/cm).

Table 5-29c indicates that the average April–September EC values at Tracy Boulevard ranged from 0.218 dS/m (218 µS/cm) to 977 dS/m (977 µS/cm), with an average of 0.607 dS/m (607 µS/cm). The decrease in the distribution of EC at Tracy Boulevard was greater at the higher EC values, with an average reduction of 0.034 dS/m (34 µS/cm).

Although the monthly EC values might increase or decrease slightly, depending on the changes in the monthly flows, the range of salinity during the irrigation season of April–September in the SJR at

Vernalis and in the southern Delta channels under LSJR Alternative 2 would generally be reduced or remain very similar to baseline. Impacts would be less than significant.

Adaptive Implementation

As described under Impact WQ-1 for LSJR Alternative 2, adaptive implementation method 1 could only increase flow relative to LSJR Alternative 2; method 2 could cause temporary reductions in flow relative to LSJR Alternative 2, but these reductions would be offset by increases in flow at other times and flow could not go below what is required by other agencies or processes; method 3 is not applicable to LSJR Alternative 2; and method 4 would rarely affect flows. Because of the limited effect of adaptive implementation on flow, and, therefore EC, it is anticipated that adaptive implementation would not change the impact determination for the effects of LSJR Alternative 2 on EC for agricultural beneficial uses described above. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Table 5-29a indicates that the average April–September EC values at Vernalis ranged from 0.200 dS/m (200 µS/cm) to 0.608 dS/m (608 µS/cm), with an average of 0.418 dS/m (418 µS/cm) under LSJR Alternative 3. The decrease in the distribution of EC at Vernalis relative to baseline was greater at the higher EC values, with an average reduction of 0.078 dS/m (78 µS/cm). This reduction in Vernalis EC was caused by the general increase in the monthly flows compared to the baseline flows at Vernalis.

Table 5-29b indicates the average April–September EC values at Brandt Bridge ranged from 0.206 dS/m (206 µS/cm) to 0.713 dS/m (713 µS/cm), with an average EC of 0.459 dS/m (459 µS/cm) under LSJR Alternative 3. The decrease in the distribution of EC at Brandt Bridge relative to baseline was greater at the higher EC values, with an average reduction of 0.086 dS/m (86 µS/cm). Table 5-29c indicates that the average April–September EC values at Tracy Boulevard ranged from 0.220 dS/m (220 µS/cm) to 0.923 dS/m (923 µS/cm), with an average of 0.540 dS/m (540 µS/cm). The change in the distribution of EC at Tracy Boulevard for LSJR Alternative 3 was greatest for the higher EC values, with an average reduction of 0.100 dS/m (100 µS/cm) relative to baseline.

The range of salinity during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels under LSJR Alternative 3 would generally be reduced when compared to baseline. Therefore, agricultural beneficial uses would not be impaired because crops are not harmed by application of water with lower salinity. Impacts would be less than significant.

Adaptive Implementation

As described under Impact WQ-1 for LSJR Alternative 3, adaptive implementation method 1 would not allow flow to go below that of LSJR Alternative 2; methods 2 and 3 could cause temporary reductions in flow relative to LSJR Alternative 2, but these reductions would be offset by increases in flow at other times and flow could not go below what is required by other agencies or processes; and method 4 would rarely affect flows. Because of the limited effect of adaptive implementation on flow, and, therefore EC, it is anticipated that adaptive implementation would not change the impact determination for the effects of LSJR Alternative 3 on EC for agricultural beneficial uses described above. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Table 5-29a indicates that the average April–September EC values at Vernalis ranged from 0.217 dS/m (217 µS/cm) to 0.545 dS/m (545 µS/cm), with an average of 0.389 dS/m (389 µS/cm) under LSJR Alternative 4. The reductions in EC at Vernalis for LSJR Alternative 4 were greatest for the higher EC values, with an average reduction of 0.108 dS/m (108 µS/cm). This reduction in Vernalis EC was caused by the general increase in the monthly flows compared to the baseline flows at Vernalis.

Table 5-29b indicates that the average April–September EC values at Brandt Bridge ranged from 0.224 dS/m (224 µS/cm) to 0.641 dS/m (641 µS/cm), with an average EC of 0.427 dS/m (427 µS/cm) under LSJR Alternative 4. The change in the EC at Brandt Bridge relative to baseline was greatest for the higher EC values, with an average reduction of 0.117 dS/m (117 µS/cm). Table 5-29c indicates that the average April–September EC values at Tracy Boulevard ranged from 0.239 dS/m (239 µS/cm) to 0.833 dS/m (833 µS/cm), with an average of 0.504 dS/m (504 µS/cm). The change in the distribution of EC at Tracy Boulevard for LSJR 4 was greatest for the higher EC values, with an average reduction of 0.137 dS/m (137 µS/cm) relative to baseline.

The range of salinity during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels under LSJR Alternative 4 would generally be reduced when compared to baseline. Therefore, agricultural beneficial uses would not be impaired because crops are not harmed by application of water with lower salinity. Impacts would be less than significant.

Adaptive Implementation

As described under Impact WQ-1 for LSJR Alternative 4, adaptive implementation method 1 would not allow flow to go below that of LSJR Alternative 3; methods 2 and 3 could cause temporary reductions in flow relative to LSJR Alternative 2, but these reductions would be offset by increases in flow at other times and flow could not go below what is required by other agencies or processes; and method 4 would rarely affect flows. Because of the limited effect of adaptive implementation on flow, and, therefore EC, it is anticipated that adaptive implementation would not change the impact determination for the effects of LSJR Alternative 4 on EC for agricultural beneficial uses described above. Impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3 (No impact)

Under SDWQ Alternatives 2 and 3, the Vernalis and southern Delta salinity objectives would be changed to a year-round value of 1.0 dS/m and 1.4 dS/m, respectively. However, under SDWQ 2 and 3, it is expected the program of implementation would maintain EC at Vernalis at or below 0.7 dS/m April-August and 1.0 dS/m September-March as a running 30-day average, similar to current conditions, through actions undertaken by USBR in accordance with its water rights. Changes in EC that may occur downstream of Vernalis are dependent on conditions at Vernalis and within the southern Delta. As modeled for baseline and the LSJR alternatives, additional water is not released from upstream reservoirs to meet EC objectives farther downstream in the southern Delta for the SJR at Brandt Bridge and Old River at Tracy Boulevard.

As explained above, under SDWQ Alternatives 2 and 3, there would be no change in operations affecting southern Delta salinity relative to baseline, and water quality at Vernalis would be unaffected. Merely changing the water quality objectives would not affect water quality in the southern Delta relative to baseline. Therefore, the historical range of salinity (between 0.2 and 1.2 dS/m [200 and 1,200 µS/cm]) is expected to remain unchanged under SDWQ Alternatives 2 and 3. It is not anticipated that agricultural beneficial uses would be impaired with SDWQ Alternatives 2 or 3 because salinity would not change as a result of implementing SDWQ Alternatives 2 or 3. Therefore, there would be no impacts, and implementation of SDWQ Alternatives 2 or 3 would not affect impacts associated with LSJR Alternatives 2, 3, or 4.

Impact WQ-3: Substantially degrade water quality by increasing pollutant concentrations caused by reduced river flows

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

There are multiple water quality constituents that are of concern within the study area. Impact WQ-3 focuses on water quality constituents that are not covered in other locations within this document. Chemicals that are of concern for drinking water quality, such as bromide and salinity are discussed in more detail in Chapter 13, *Service Providers*. A detailed discussion of the impact of potential changes in water temperature and other water quality indicators associated with the LSJR and SDWQ alternatives on fisheries resources can be found in Chapter 7, *Aquatic Biological Resources*. In addition, potential effects on turbidity, erosion, and siltation are discussed in Chapter 6, *Flooding, Sediment, and Erosion*, and Chapter 7, *Aquatic Biological Resources.* Impacts WQ-1 and WQ-2, above, emphasize potential salinity effects because agricultural beneficial uses would be sensitive to changes in salinity extensive EC data are available, and salinity has specific water quality objectives. Potential changes in salinity indicate how other water quality constituents would change. Impact WQ-3 focuses on other water quality constituents that may be affected by changes in flow.

Changing the baseline monthly flows would change the dilution of any pollutants (e.g., 303(d) pollutants listed in Table 5-4) that enter the LSJR or its tributaries or the southern Delta as a point source or non-point source. The source loading of 303(d) pollutants would either remain constant or be caused by storm water runoff or agricultural drainage, and would be independent of the reservoir releases occurring under baseline conditions and the LSJR alternatives. Therefore, the change in concentration would be the inverse of the change in flow (flow ratio). In other words, it is reasonable to assume the concentration of a 303(d) pollutant would increase with a decrease in flow. DO is not considered to be pollutants per se, but it is a water quality indicator that can also be improved by increased flow.

Implementation of the LSJR and SDWQ alternatives would not lead to changes in the Upper SJR flow or pollutant concentrations upstream of the confluence of the LSJR with the Merced River.

Changes in flow in the Merced River associated with the LSJR alternatives would change the dilution of pollutants in the Merced River and would change flows and dilution in the LSJR downstream of the Merced River. The changes downstream would be smaller than in the tributary river because the LSJR baseline flows are greater than the flows in the tributary river. Changes in the Tuolumne River flow would change the dilution and concentrations of pollutants in the Tuolumne River, with smaller changes in the LSJR downstream of the Tuolumne. Changes in the Stanislaus River flows would change the dilution of pollutants in the Stanislaus River and in the LSJR downstream of the Stanislaus (e.g., at Vernalis).

Changes in flow at Vernalis can change water quality through many parts of the southern Delta. In general, increases in flow at Vernalis would improve water quality in the southern Delta by diluting pollutant concentrations with the addition of relatively clean water from the Stanislaus, Tuolumne, and Merced Rivers. DO within the Stockton DWSC is also generally improved (increased) by increases in flow through several different mechanisms including a reduction in the concentration of algae from reduced travel time for algal growth (Central Valley Water Board 2014; ICF International 2010). Potential effects on southern Delta EC are discussed specifically above in Impacts WQ-1 and WQ-2. However, potential effects of changes in flow on other water quality constituents in the southern Delta are captured here under Impact WQ-3.

Changes in flow at Vernalis could also affect other portions of the Delta. Increases in flow at Vernalis could either contribute to increased Delta exports or to increased Delta outflows. Delta outflow helps to prevent salinity intrusion, so increases in Vernalis flow could potentially help to prevent salinity intrusion, although the effect of the LSJR alternatives on Delta outflow are generally relatively small compared to total Delta outflow, because the SJR Watershed only contributes approximately 13 percent to total Delta inflow (based on DAYFLOW data for water years 1995–2013).

The impact assessment is based on the comparison of the baseline flows to the LSJR Alternative flows. Because water quality is generally poorest at low flows, changes in the cumulative flow distribution at the low end of the distribution are most likely to affect water quality. For this reason, the potential effect of changes in flow on changes in water quality were evaluated primarily by looking at changes in the 10th percentile, but changes in median flows were also considered.

In general the LSJR Alternatives would cause flows to increase, which would reduce pollutant concentrations and improve any chronic water quality problems. However, it is possible that in some years, some months will experience flow reductions. These flow reductions would be unlikely to be detrimental because they would be of short duration. Furthermore, flows could not be reduced below levels required by other agencies or through other processes. Because a short-term reduction in flow would need to be relatively large to potentially cause water pollution problems, a threshold of a 50 percent increase in pollutant concentration was used. A 50 percent increase in pollutant concentration would occur if there was a one-third reduction in flow. Therefore, a reduction in 10th percentile or median flows of more than 33 percent for a particular month was considered to be potentially significant and subject to further evaluation. In addition, smaller reductions in flow (10 percent) would also be considered to be potentially significant if they occurred for multiple months.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

For each of the three eastside tributaries and the LSJR, flows generally stayed about the same (for the Stanislaus River) or increased with LSJR Alternative 2 (Tables 5-17a through 5-17d). While only a few months showed decreases in flows on all rivers, median flows on the Stanislaus River decreased by more than 10 percent during March. However, because baseline median flows in March on the Stanislaus River were moderately high (which would generally be associated with low pollutant concentrations), this decrease in flow is unlikely to cause an exceedance of a water quality objective. None of the monthly 10th percentile or median flows decreased by more than 33 percent relative to baseline. Impacts would be less than significant.

Adaptive Implementation

As described under Impact WQ-1 for LSJR Alternative 2, adaptive implementation method 1 could only increase flow relative to LSJR Alternative 2; method 2 could cause temporary reductions in flow relative to LSJR Alternative 2, but these reductions would be offset by increases in flow at other times and flow could not go below what is required by other agencies or processes; method 3 is not applicable to LSJR Alternative 2; and method 4 would rarely affect flows. Because of the limited effect of adaptive implementation on flow, and, therefore water quality, it is anticipated that adaptive implementation would not change the impact determination for the effects of LSJR Alternative 2 on pollutant concentrations as described above. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

For each of the three eastside tributaries and the LSJR, low and median flows generally increased with LSJR Alternative 3 (Tables 5-17a through 5-17d). Few months showed decreases in flows and no months had 10th percentile or median flows that decreased by more than 33 percent. There were two instances of median flows decreasing by more than 10 percent (March on the Tuolumne River and February on the SJR at Vernalis). In these instances, because baseline median flows were moderately high, it is reasonable to assume that these decreases would not cause water quality problems because there would still be sufficient flow in the river to reduce concentrations of pollutants (flow would still be much higher than baseline summer median flows). Impacts would be less than significant.

Adaptive Implementation

As described under Impact WQ-1 for LSJR Alternative 3, adaptive implementation method 1 would not allow flow to go below that of LSJR Alternative 2; methods 2 and 3 could cause temporary reductions in flow relative to LSJR Alternative 2, but these reductions would be offset by increases in flow at other times and flow could not go below what is required by other agencies or processes; and method 4 would rarely affect flows. Because of the limited effect of adaptive implementation on flow, and, therefore water quality, it is anticipated that adaptive implementation would not change the impact determination for the effects of LSJR Alternative 3 on pollutant concentrations as described above. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

For each of the three eastside tributaries and the LSJR, low and median flows generally increased with LSJR Alternative 4 (Tables 5-17a through 5-17d). Few months showed decreases in flows and none of the monthly 10th percentile or median flow decreased by more than 10 percent. Impacts would be less than significant.

Adaptive Implementation

As described under Impact WQ-1 for LSJR Alternative 4, adaptive implementation method 1 would not allow flow to go below that of LSJR Alternative 3; methods 2 and 3 could cause temporary reductions in flow relative to LSJR Alternative 2, but these reductions would be offset by increases in flow at other times and flow could not go below what is required by other agencies or processes; and method 4 would rarely affect flows. Because of the limited effect of adaptive implementation on flow, and, therefore water quality, it is anticipated that adaptive implementation would not change the impact determination for the effects of LSJR Alternative 4 on pollutant concentrations as described above. Impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3 (No impact)

SDWQ Alternatives 2 and 3 would not result in an increase in pollutant concentrations because the SJR at Vernalis EC would continue to be maintained as it is under baseline conditions. As a result, SDWQ Alternatives 2 and 3 would not cause a change in flow. Therefore, WQ-3 impacts would not occur.

5.4.4 Impacts and Mitigation Measures: Extended Plan Area

Similar to the plan area, changing the flows in the rivers in the extended plan area would change the dilution of any water quality constituent of concern (e.g., 303(d) pollutants identified in Section 5.2.1, *San Joaquin River Basin and Southern Delta Hydrology and Water Quality)* that enter the rivers as a point source or non-point source. The source loading would either remain constant or be caused by storm water runoff or drainage, and would be independent of the reservoir releases occurring under baseline conditions or the LSJR alternatives with or without adaptive implementation. Therefore, the change in concentration would be the inverse of the change in flow. In other words, it is reasonable to assume the concentration would decrease with an increase in flow. There is a relatively small volume of water that could be affected by the flow requirements in the extended plan area on the three rivers. In general the LSJR alternatives with or without adaptive implementation would cause flows to increase, which would reduce concentrations and improve any chronic water quality problems. Furthermore, the water quality on the rivers in the extended plan area is generally high quality (Kennedy-Jenks Consultants 2013, 2014). As such, it is expected that additional water in the rivers would not degrade the existing water quality under LSJR Alternatives 2, 3, or 4 with or without adaptive implementation. Impacts would be less than significant.

Water quality could be affected by changes in reservoir elevation (storage levels) under the LSJR alternatives with or without adaptive implementation on the Stanislaus and Tuolumne Rivers. There are no substantial reservoirs on the Merced River in the extended plan area. The frequency with which reservoirs in the extended plan area are drawn down to lower storage levels would depend on the seniority of water rights, how water rights are conditioned to implement the flow objectives, and the duration and frequency of bypass flows. While the changes in storage levels may be greatest in critically dry and dry years, particularly under LSJR Alternatives 3 and 4 with or without adaptive implementation, there may be some changes in above normal years and wet years. To the extent that water in the extended plan area is bypassed to meet the unimpaired flow requirement, instead of being diverted to storage, reservoir levels in the extended plan area would decline. Water quality in upstream reservoirs in the Stanislaus and Tuolumne Watersheds is generally high quality (Kennedy-Jenks Consultants 2013). Furthermore, reservoir volume reductions would have minimal effects on most water quality constituents (e.g., mercury) because the reduction in storage would result from water (and the constituent) flowing out of the reservoir. In other words, the concentrations of water quality constituents would not change or increase relative to baseline and it is unlikely that the water quality would be degraded. Impacts would be less than significant under LSJR Alternatives 2, 3, or 4 with or without adaptive implementation.

5.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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5.6.2 Personal Communications

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Chapter 6
Flooding, Sediment, and Erosion

6.1 Introduction

This chapter describes the environmental setting for flooding, sediment (including gravel, sand, and silt), and erosion and the regulatory background associated with flooding, sediment, and erosion. It also evaluates environmental impacts on river channel flooding, erosion, and sediment transport that could result from the Lower San Joaquin River (LSJR) alternatives, the significance of any impacts, and, if applicable, proposes mitigation measures that would reduce significant impacts.

As described in Chapter 1, *Introduction*, the plan area generally includes those portions of the San Joaquin River (SJR) Basin that divert water from or otherwise support beneficial use (e.g., surface water supplies) from the three eastside tributaries[1] of the LSJR. These include the Stanislaus River from and including New Melones Dam and Reservoir to its confluence with the LSJR; the Tuolumne River from and including New Don Pedro Dam and Reservoir to its confluence with the LSJR; the Merced River from and including New Exchequer Dam and Lake McClure to its confluence with the LSJR; and, the SJR between its confluence with the Merced River and downstream to Vernalis (i.e., LSJR). The flow in the three eastside tributaries is primarily controlled by the three rim dams[2]; consequently, in this chapter, the rivers are only evaluated below these dams.

The extended plan area, also described in Chapter 1, *Introduction,* generally includes the area upstream of the rim dams. The area of potential effects for this area is similar to that of the plan area and includes the zone of fluctuation around the numerous reservoirs that store water on the Stanislaus and Tuolumne Rivers. (Merced River does not have substantial upstream reservoirs that would be affected.) It also includes the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Board determined whether the plan amendment would cause any adverse impact for each environmental category in the checklist and provided a brief explanation for its determination. Impacts that are listed as "Potentially Significant Impacts" are discussed in detail in this chapter. Appendix B, Section IX, identified the LSJR alternatives as having a potentially significant impact by (1) substantially altering the existing drainage pattern, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site, and (2) substantially altering the existing drainage pattern, including through the alteration of the course of a stream or river, or substantially increasing the rate or amount of surface runoff in a manner that would result in flooding on- or offsite. In addition, whether or not people or structures

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[1] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[2] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

are exposed to a significant risk of loss, injury or death involving flooding is addressed. Accordingly, this chapter evaluates these potential impacts of the LSJR alternatives on the alteration of the existing streams or rivers in the plan area. Impacts were assessed using results from the State Water Board's Water Supply Effects (WSE) monthly model to compare the changes in flows to channel capacities for each alternative and, specifically, to assess how frequently the channel capacities were exceeded, which could result in flooding, sediment, and erosion.

Table 6-1 summarizes the potential impacts of the LSJR alternatives. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 each include four methods of adaptive implementation. The substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 6-1 summarizes impact determinations with and without adaptive implementation.

Any change in salinity in the southern Delta as a result of southern Delta water quality (SDWQ) Alternatives 2 or 3 is expected to be similar to that of the historic range of salinity because Vernalis water quality would be maintained under the SDWQ alternatives through the program of implementation. Furthermore, change in water quality does not affect flooding, sedimentation, or erosion. Therefore, the SDWQ alternatives are not discussed in this chapter. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on flooding, sediment, and erosion. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

Impacts related to the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to actions and methods of compliance.

Table 6-1. Summary of Flooding, Sediment, and Erosion Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact FLO-1: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternative 2	Substantial erosion is caused by high flow events resulting from flood control releases of peak flows. These flows would not increase under LSJR Alternative 2. On average, the occurrence of monthly flows greater than	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	1,500 cfs on the Stanislaus River would be similar to baseline and would not influence stream bank erosion. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in an increase in substantial erosion or siltation.		
LSJR Alternative 3	Very occasional gravel transport and bank erosion would occur in the upper gravel-bedded reaches of the three eastside tributaries. The amount of bank erosion is limited by flood stage action levels, which is the river stage at which actions are presumed to occur to reduce flood risk, and existing bank armoring. Flows greater than 1,500 cfs on the Stanislaus River would occur with greater frequency than baseline, particularly during April to June; however, these flows are not sufficiently high to increase stream bank erosion. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in an increase in substantial erosion or siltation.	Less than significant	Less than significant
LSJR Alternative 4	Similar to Alternative 3, there would be occasional gravel transport and bank erosion in the upper gravel-bedded reaches of the three eastside tributaries. The amount of bank erosion is limited by the action stage, which is the river stage at which actions are presumed to occur to reduce flood risk, and existing bank armoring. Flows greater than 1,500 cfs on Stanislaus River would occur with greater frequency than baseline, particularly during April to June; however, these flows are not sufficiently high to increase stream bank erosion. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in an increase in substantial erosion or siltation.	Less than significant	Less than significant
Impact FLO-2: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or offsite			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternative 2	Controlled reservoir releases would be much lower than channel capacities and no significant flooding would occur outside of floodway. LSJR Alternative 2 would not change reservoir flood storage capacity and would not violate USACE flood reservation so there would be no changes in flood control operation procedures during major flood events. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in flooding. Consequently, people or structures would not be exposed to a significant risk of loss, injury or death involving flooding.	Less than significant	Less than significant
LSJR Alternative 3	Similar to Alternative 2 with respect to flood control operations. Substantial alterations of the existing drainage patterns would not occur and would not result in flooding. Consequently, people or structures would not be exposed to a significant risk of loss, injury or death involving flooding.	Less than significant	Less than significant
LSJR Alternative 4	Similar to Alternative 2, with respect to flood control operations. Substantial alterations of the existing drainage patterns would not occur and would not result in flooding. Consequently, people or structures would not be exposed to a significant risk of loss, injury or death involving flooding.	Less than significant	Less than significant

cfs = cubic feet per second

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description* and summarized in Section 6.4.2, *Methods and Approach*, of this chapter.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives established in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

6.2 Environmental Setting

The information in this section provides context for the impacts evaluation of the LSJR alternatives within the plan area. The LSJR alternatives neither involve ground-disturbing activities nor do they increase the potential for high peak flows that could result in substantial sediment transport of gravels and sands that would cause substantial erosion of stream banks or stream levees. The LSJR alternatives would alter the timing of flows in the three eastside tributaries and the LSJR but would not significantly change peak flow rates or the rates of bank erosion or sedimentation within the plan area. Potential impacts associated with sediment transport that are expected to occur under the

LSJR alternatives in relation to fisheries habitat are discussed in Chapter 7, *Aquatic Biological Resources*. Consequently, this section does not provide information on overall basin erosion and sedimentation.

6.2.1 Overview of the Bay-Delta and Central Valley Basin

Chapter 2, *Water Resources*, describes in detail the hydrology, dams, water diversions, operating agreements, and flow requirements of the plan area. The present chapter provides additional information on the channel geomorphology and channel capacities relevant to evaluating the potentials for flooding, and sedimentation, and erosion impacts as described in Sections 6.4.2, *Methods and Approach*, and 6.4.3, *Impacts and Mitigation Measures*, of this chapter.

The Central Valley is a low-lying basin that receives water and sediment from the surrounding highlands of the Sierra Nevada to the east and the Coast Ranges to the west. The Sacramento River drains the north end of the Central Valley while the SJR drains the south end. The Sacramento River and SJR flow along the lowest elevation portions of the Central Valley as low gradient rivers. The two rivers meet in the Delta and flow to the Pacific Ocean through Carquinez Strait and San Francisco Bay.

Streams entering the SJR from both the Sierra Nevada and the Coast Ranges have steeper gradients as they exit their respective mountain front and then become progressively lower gradient as they reach the lowermost SJR Basin and join the LSJR. In their upper portions, the Sierra Nevada tributaries are incised into bedrock, and the larger dams are placed in these bedrock reaches. Further downstream, the streams leave the bedrock and begin flowing within channels formed of the sediment they transport (i.e., they become alluvial channels). The upper river reaches are steeper and gravel dominated (and are considered transport reaches) while the lower reaches are lower gradient and sand dominated (and are considered response reaches, constantly adjusting their channel bed to the available sediment, and water supply).

The Sierra Nevada streams generally have more water discharge and are lower gradient than the streams that drain the Coast Range. The Sierra Nevada tributaries have also been modified by gold dredging in their upper gravel-bedded reaches as well as within-stream and stream adjacent gravel mining for aggregate (Kondolf et al. 1996, 2001; McBain and Trush 2000; Weissmann et al. 2005). The LSJR and the three eastside tributaries are described in the following sections.

6.2.2 Lower San Joaquin River, Delta, and Tributaries

The LSJR is a very low gradient river throughout the plan area and generally has a meandering pattern. The three eastside tributaries are generally steeper, confined gravel-bedded channels in their upper portion. The reservoirs on the tributaries control and maintain flows in the rivers. They transition to low gradient, sand-bedded meandering channels in their middle to lower reaches. The three eastside tributaries and the LSJR are constrained by channel modifications, development encroachment, agricultural encroachment and levees that limit their ability to flood the adjacent landscape or to have excessive channel erosion. The LSJR is further constrained by the alluvial fan sediment deposition of all tributary streams from both the Sierra Nevada and the Coast Ranges.

Reservoirs

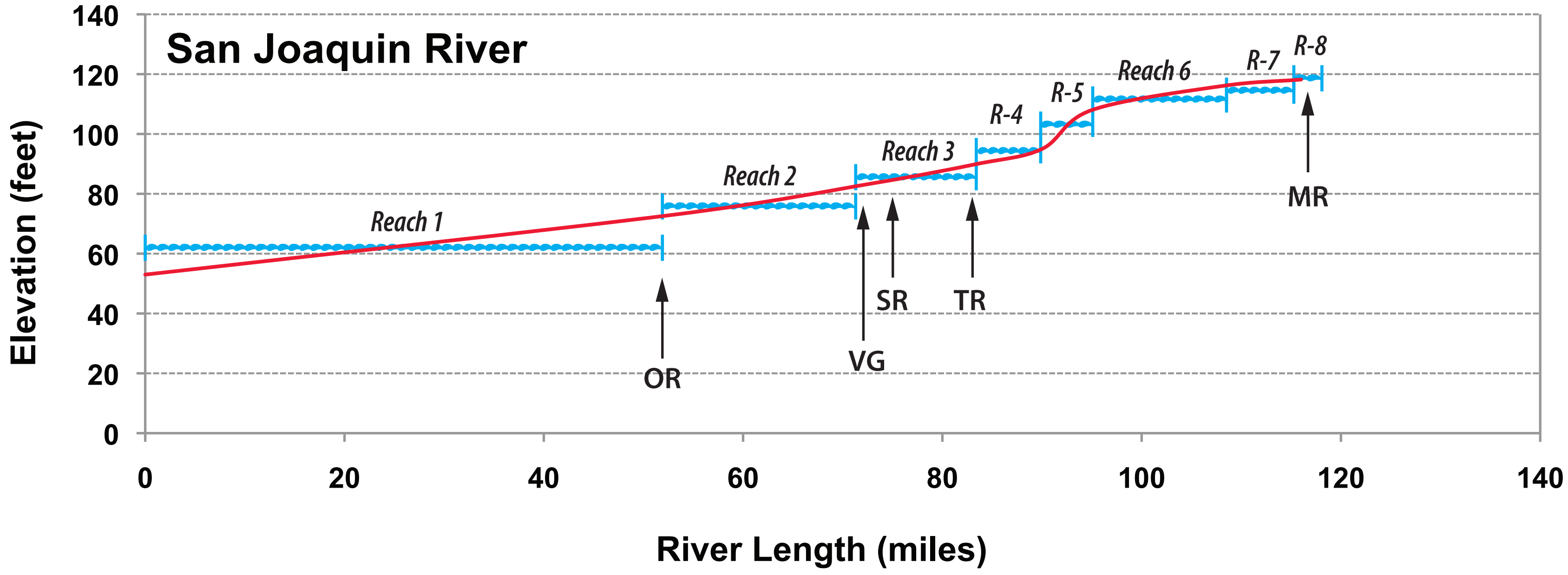
Flood control operations for Lake McClure, New Don Pedro Reservoir, and New Melones Reservoir are developed as part of the Water Control Plans by the USACE Sacramento District, according to national flood control regulations. (33 C.F.R. § 208.11.) Based on hydrologic engineering studies of rainfall and snowmelt floods, standard project floods and reservoir design floods are identified for the reservoir. The seasonal rainfall and snowmelt flood control curves (i.e., empty storage space) are based on these design storms. For example, the rainfall flood control storage for Lake McClure increases linearly from 0 thousand acre-feet (TAF) at the end of August to 175 TAF at the end of September to 350 TAF at the end of October. The flood control space remains at 350 TAF until March 15, and is reduced linearly to 0 TAF on June 15. Flood control releases are made whenever the reservoir storage goes above the maximum flood control storage during rainfall runoff events, with a maximum flood control release flow of 6,000 cubic feet per second (cfs) at Stevinson. If necessary, additional storage space is reserved from the beginning of March to the end of July to prevent uncontrolled spilling. A constant supplemental river release is computed, based on snowpack and snowmelt forecasts. The maximum snowmelt storage space is 400 TAF from April 1 to May 15. Emergency spillway releases are regulated with a similar process that requires higher releases during very high inflow events once the Lake McClure elevation is above the spillway crest at 837 feet (ft) (30-ft spillway gates). New Don Pedro and New Melones Reservoirs have similar flood control and flood control operating rules.

Lower San Joaquin River and Delta

The SJR flows from high in the Sierra Nevada, drains west into the SJR Basin, turns north and drains to the Delta, a distance of approximately 180 miles below Friant Dam. Below Friant Dam, the river has deposited a wide alluvial fan that it now flows across (McBain and Trush 2002; Weissmann et al. 2005). At the bottom of this alluvial fan, the river turns north and flows towards the Delta. Figure 6-1 shows the SJR longitudinal profile from Friant Dam downstream to the Delta. Table 6-2 describes the eight LSJR channel reaches from the Merced River north. The SJR channel reaches are divided based on differences in floodplain width, connectivity of the channel to the floodplain, and encroachment. The SJR is generally a meandering channel in its lower reach; however, the width of the meander belt is related to space constraints placed upon it by both the San Joaquin Valley width and its tributary river and creek alluvial fans (Weissmann et al. 2005). Upstream of the Merced River confluence the SJR meandering floodplain is several miles wide because the Valley itself is wide and the Sierra Nevada tributaries (Chowchilla and Kings Rivers) do not have sufficient water and sediment available to fill the central basin and constrain the SJR (Weissmann et al. 2005).

Near the Merced River (LSJR River Mile [RM] 119), the LSJR floodplain becomes narrower because the Valley itself narrows and the Merced River alluvial fan has sufficient sediment deposition to constrain the LSJR's ability to migrate east. At the Merced River confluence, the SJR floodplain narrows from more than 3 miles to less than 1 mile. The channel pattern and floodplain width is similar from this location for approximately 44 miles north, past the confluence with the Tuolumne River at RM 83.5 to the confluence with the Stanislaus River at RM 75. The LSJR floodplain is also constrained by stream alluvial fans from the Coast Ranges to the west. These alluvial fans include Orestimba Creek at RM 109 and Del Puerco Creek at RM 93. North of the Stanislaus River at RM 75, the Valley and LSJR floodplain again widens towards the southern Delta (Weissmann et al. 2005). The LSJR has a very low gradient along this entire reach ranging from 0.000036 to 0.000284 and is sand-bedded (USACE 2002).

The LSJR generally forms a meandering pattern with features shown in Figures 6-2a and 6-2b. Meanders form by water flow eroding the channel bottom, forming a deep pool that also undercuts and erodes the adjacent channel bank. That eroded sediment is transported downstream and deposited, forming a shallow spot or riffle in the channel, which is followed by another pool with



MR	Merced River - RM 118
TR	Tuolumne River - RM 83
SR	Stanislaus River - RM 75
VG	Vernalis Gage - RM 72
OR	Old River Distributary - RM 53

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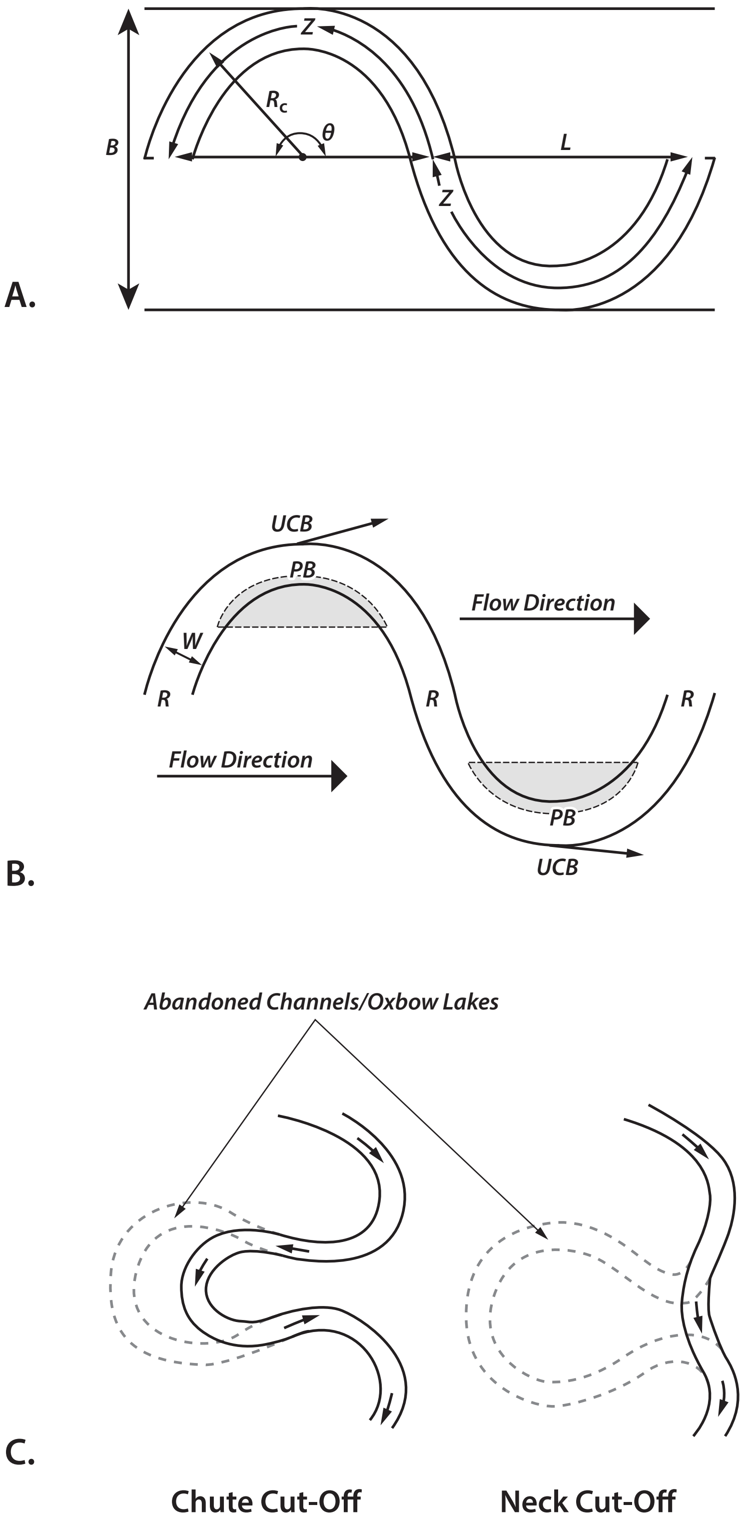
Figure 6-1
San Joaquin River Longitudinal Profile



R_c	Bend radius
B	Meander belt width
Z	Riffle spacing
θ	Meander arc angle
L	Wavelength
p	Sinuosity = $\frac{2Z}{L}$

Source: Simon & Castro, 2003

R	Riffle
PB	Point bar
UCB	Undercut bank
W	Channel width
➚	Migration Vector

Source: Trush et al., 2000

Source: Allen, 1965

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Figure 6-2
Meandering Channel Characteristics

an eroding channel bank and then another riffle. Sediment is also deposited on the inside bend in the vicinity of the pool forming a point bar. Point bar sediment is commonly deposited during high flows and often forms arcuate ridges (scroll ridges, scroll bars) along the point bar that are visible at lower flows.

This erosion-deposition pattern causes the river channel to progressively erode the banks and “migrate” downstream. As the channel configuration changes, individual meanders may be cut off producing an oxbow lake (Figure 6-2c). The cutoff may occur at the meander neck (neck cutoff) or by flows across the point bar surface that erode a sufficiently deep channel to capture stream flow (chute cutoff) (Figure 6-2c).

Erosion and sediment transport occur during higher or flood flows, which can mobilize the bed sediment and undercut stream banks; consequently, overall meander channel dimensions reflect the high flows associated with individual river systems (McBain and Trush 2002; Larsen et al. 2006; Michalkova et al. 2011). Many factors control the rate of meander movement. These factors include magnitude of the flow, bed sediment size, bank erosional resistance and meander geometry. Higher flows, often approaching channel capacity, are required to move larger amounts of coarser sediment. Bank resistance can be influenced by numerous factors such as levee construction to contain flood flows, placement of large rocks or physical structures to prevent bank erosion, presence of bridge abutments, and local variations of natural bank materials (e.g., sediment size and the presence of bedrock or cohesive soils).

Finer sediment (fine sand, silt, and clay) is transported in suspension and is a major source of water turbidity. The amount of suspended sediment transported at a given time is generally related to discharge; that is, higher discharges can carry larger amounts of suspended sediment (Wright and Schoellhamer 2005; Saleh et al. 2007; Figure 19D for the SJR at Vernalis). However, the amount of fine sediment that a given discharge can possibly carry varies widely. For example, Kratzer and Shelton (1998: Figure 33) show that at 10,000 cfs suspended sediment concentrations in the SJR at Vernalis can vary from approximately 60 to more than 540 milligrams per liter. On the LSJR, dams and increased water use have reduced river flow, which reduces sediment transport (McBain and Trush 2002). Combined with the effects of levees that have been constructed to contain peak flows, the meander migration rates on the LSJR have been minimized (McBain and Trush 2002).

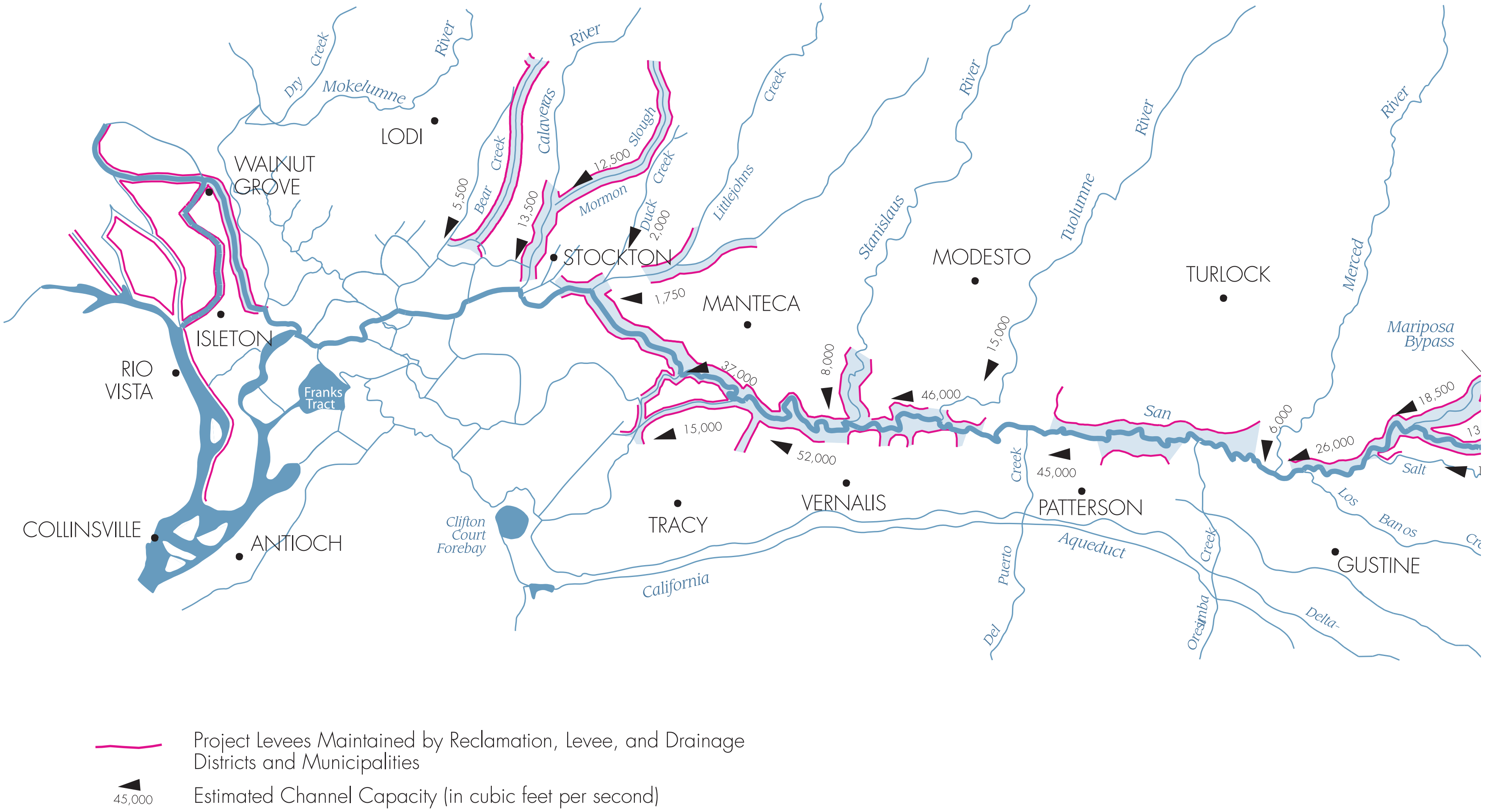
Figure 6-3 and Tables 6-3, 6-4, and 6-5 show the channel capacities, National Weather Service (NWS) flood categories, and observations of channel conditions and local inundation of the LSJR and the three eastside tributaries, respectively. The levee system shown in Figure 6-3 is part of the State Plan of Flood Control, which is part of the combined state-federal flood management system (DWR 2010). It has undergone a system-wide evaluation and update to improve flood control and management as part of the Central Valley Flood Protection Plan (DWR 2011, 2012). Private levees that are not part of the State Plan of Flood Control occur on the Stanislaus, Tuolumne, and Merced Rivers are not shown in Figure 6-3.

Table 6-2. Lower San Joaquin River Channel Reaches

Reach	1	2	3	4	5	6	7	8
River Mile	0 – 53	53 – 73	73 – 83.5	83.5 – 90	90 – 95	95 – 108	108 – 116	116 – 118
Gradient (%)	0.000036	0.000057	0.000234	0.000032	0.00011	0.000146	0.000284	0.000086
Description	Distributary channels downstream of Old River flowing towards junction with Sacramento River. Flow generally constrained between levees which protect adjacent Delta islands.	Floodplain continues to widen to Old River cutoff. Channel begins to become distributary at Paradise Cut and then Old River; main San Joaquin channel continues around east side of Delta. Vernalis stream gage at RM 72.	Floodplain 2 miles wide below Tuolumne confluence; continues to widen downstream. Tight meanders, then meander height increases with floodplain width. Main channel generally isolated from adjacent floodplain. Stanislaus enters at RM 75. SJR National Wildlife Refuge between Tuolumne and Stanislaus River confluences.	Floodplain widens to more than 2 miles. Laird Slough flows north from north side of river. Tuolumne River enters at approximately RM 83 and floodplain narrows.	Channel constrained with narrow floodplain less than 0.6 mile wide.	Floodplain and abandoned channels are adjacent to main channel but not generally connected. Floodplain up to 2 miles wide. Downstream end of reach terminates at Sewage Disposal Ponds southwest of Modesto.	Channel somewhat constrained with floodplain less than 1 mile wide. Channel less connected to floodplain than Reach 8. Ends at Crows Landing Bridge.	Meander Channels connected to main channel. Merced River enters at RM 118.

Source: McBain & Trush, Inc. 2000.

RM = River Mile



Source: www.water.ca.gov/floodmgmt/docs/map_sac&sj_designflows.pdf

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Figure 6-3
Channel Capacities and Levees

The LSJR channel capacity increases downstream from an estimated 26,000 cfs just above the Merced River confluence, to a designed capacity of 45,000 cfs below that confluence and increases downstream of the Tuolumne and Stanislaus River confluences as well. Some flow is diverted at the Paradise Cut, and additional flow is diverted at Old River. Evaluations for the Central Valley Flood Protection Plan indicate that, in some cases, channel capacity may be higher or lower than the estimated or design capacities (Table 6-3). On the LSJR present channel capacities are uncertain downstream of the Merced River confluence, downstream of the Tuolumne River confluence, and from Old River to Burns Cutoff (Table 6-3). Additional evaluation is needed in these three reaches (DWR 2011).

The above capacities are mostly within the levee system, which protects the adjacent meander belt floodplain and agricultural land. The San Joaquin River National Wildlife Refuge, located approximately between the confluences of the Tuolumne and Stanislaus Rivers, can receive flood flows to reduce discharge downstream during floods (USFWS 2006; River Partners 2008).

The action stage for the SJR at Vernalis is 22,000 cfs, and the minor flooding level for the LSJR is 34,000 cfs (NWS n.d.). Action stage is the point on a rising stream (i.e., the water discharge is increasing and expected to continue to increase) at which some type of mitigation action should be taken in preparation for possible significant hydrologic activity (NWS n.d.). Minor flooding has minimal or no property damage but possibly some public threat. Table 6-4 shows various action stages. Table 6-5 shows some local effects that occur at various discharge levels as well as reservoir flow limits.

Table 6-3. River Channel Capacity

River Channel Reach	Estimated Channel Capacity (cfs)[a]	Design Channel Capacity (cfs)[b]	Estimated Current Channel Capacity (cfs)[c]
Stanislaus River	8,000	12,000	23,000
Tuolumne River	15,000	15,000	No data
Merced River	6,000	No data	No data
San Joaquin River			
Upstream of Merced Confluence	26,000	No data	No data
Downstream of Merced Confluence	45,000	45,000	22,000–35,000[d]
Downstream of Tuolumne Confluence	46,000	46,000	25,000[d]
Downstream of Stanislaus Confluence to Paradise Cut	52,000	52,000	66,000
Paradise Cut to Old River	37,000	37,000	30,000–40,000[d]
Old River	15,000	No data	No data
Old River to Burns Cutoff	–	18,000	15,000–20,000[d]

cfs = cubic feet per second

[a] Estimated channel capacity is estimated based on general channel characteristics (DWR n.d.).

[b] Design channel capacity is based on engineering design of the channels (DWR 2011).

[c] Current Channel capacity is estimated based on updated information (DWR 2011).

[d] There are potential inadequacies with estimated current channel capacity data and additional evaluation may be required by the agency (DWR 2011).

Table 6-4. National Weather Service Flood Category, Discharge, and Elevation at Plan Area Stream Gages

	Action[a] (cfs/feet)[b]	Minor[a] (cfs/feet)	Moderate[a] (cfs/feet)	Major[a] (cfs/feet)
Stanislaus River at Orange Blossom Bridge (RM 41)	8,500 / 13.0	12,500 / 16.0	22,100 / 21.0	24,000 / 22.0
Tuolumne River at Modesto (RM 4)	6,600 / 50.5	10,400 / 55.0	36,900 / 66.0	40,000 / 67.0
Merced River at Stevinson (RM 5)	3,200 / 67.0	6,900 / 71.0	9,000 / 73.8	10,600 / 75.0
San Joaquin River at Vernalis	22,000 / 24.5	34,000 / 29.0	50,000 / 32.0	100,000 / 37.3

Source: NWS 2016a, 2016b, 2016c, 2016d.

Note: Data from the NWS Advanced Hydrologic Prediction Service. See “Scale to Flood Categories” dropdown box for flood levels (discharge cfs read from graph).

cfs = cubic feet per second

RM = River Mile

[a] High water level terminology based on the National Oceanic and Atmospheric Administration’s National Weather Service Alaska-Pacific River Forecast Center: http://www.weather.gov/aprfc/.

[b] The NWS defines action stage as the point on a rising stream (i.e., the water discharge is increasing and expected to continue to increase) at which some type of action should be taken in preparation for possible significant hydrologic activity.

Table 6-5. Local Inundation Observations and Reservoir Flow Limits

Discharge cfs / Elevation feet	Observation / Impact
Stanislaus River	
5,000 / 10.5	Inundation of several campsites in Caswell State Park (below RM 9)
5,700 / 11.0	Orange Blossom Park (RM 47) and Caswell State Park flooding in lowest areas
6,000 / 11.5	Caswell State Park access roads and park areas flooded. Orange Blossom Park lower areas flooded.
7,500 / -	New Melones power generation maximum flow
8,300 / -	New Melones maximum capacity of outlet works
Tuolumne River	
5,500 / -	New Don Pedro power generation maximum flow
10,000 / 55.0	Channel capacity through downtown Modesto.
40,000- / 67.0	Extensive flooding occurs. Flow in excess of 40,000 cfs could cause extensive damage to residential, industrial and commercial development in Modesto
Merced River	
3,200/ -	New Exchequer power generation maximum flow
6,000/ -	Estimated channel capacity
San Joaquin River at Vernalis	
15,300 / 21.0	Seepage into crops behind levee
22,000 / 24.5	Action stage
25,500 / 26.0	Severe seepage outside levees
100,000 / 37.3	Top of levees. Above this height flooding outside of levees.

Source: NWS 2016a, 2016b, 2016c, 2016d.

Note: Data from the NWS Advanced Hydrologic Prediction Service. See “Default Hydrograph” dropdown box for flood categories and flood impacts.

cfs = cubic feet per second

RM = River Mile

Recent floods were recorded in the region and on the LSJR in 1983, 1986, 1995, 1997, and 2006 (USACE 1999; Parrett and Hunrichs 2006). Generally these flood flows were contained by the LSJR levees, although there were several levee breaches during the 1997 flood (USACE 1999; DWR 2010, 2011, 2012).

The composite condition (i.e., considering all the evaluated risk factors) for the LSJR levees is primarily “higher concern” (i.e., the levees display more performance problems than those of lower concern), with stretches of “medium concern” and short stretches of “lower concern” (DWR 2012: Figure 1-7), based on detailed levee evaluations along the LSJR conducted for the Central Valley Flood Protection Plan (DWR 2010, 2011, 2012). The evaluations included numerous criteria that affect levee integrity including seepage, slope stability, erosion, and animal burrows (DWR 2011, 2012). Individual rating maps for each assessment criteria are also included (DWR 2011).

Stanislaus River

Similar to other Sierra Nevada tributaries, the Stanislaus River transitions from steeper, gravel-bedded reaches affected by gold dredging and aggregate mining, to areas where various activities encroached on the stream channel and then to a lower gradient predominantly sand-bedded reach. The upper gravel-bedded reach is confined within a bedrock canyon (Goodwin Canyon) and extends from RM 54.75 to RM 58.4. Below RM 54.75, the river exits the bedrock canyon, but the channel is incised below adjacent alluvial river terraces that constrain the channel. This reach is gravel-bedded and there are occasional dredger tailings and gravel mining on the adjacent floodplain. This reach continues downstream to Oakdale (RM 41) and Riverbank (RM 34). At Riverbank, the channel and floodplain begin to become less constrained, and channel meandering becomes prominent. As its gradient reduces and meandering increases, the channel becomes more sand dominated in this reach. The lower and upper reaches have gradients of approximately 0.0004 to 0.0047, and the lowermost channel is sand-bedded (USACE 2002). Figure 6-4 shows the Stanislaus River longitudinal profile. Table 6-6 describes the three channel reaches, divided based on characteristics of the river channel, floodplain morphology and alterations to the river channel and floodplain (Kondolf et al. 2001).

Under current conditions, gravel transport in the upper part of Reach 2 is estimated to begin in the range of 5,000 to 8,000 cfs based on observations and calculations in Kondolf et al. 2001. Kondolf et al. (2001) reports a post New Melones Dam high flow of 7,350 cfs in 1997. Figure 2-10 presents the monthly unimpaired and historical flows February–June for the Stanislaus River. This shows that flows of this level were not reached for water years 2000–2009.

The lower Stanislaus River is protected by levees to approximately RM 11 that allow a channel capacity of 8,000 cfs (Figure 6-3). These levees are not part of the State Plan of Flood Control but are called Stanislaus Local Interest Project Levees (DWR 2010, 2011, 2012). This channel capacity is the flood design flow for the entire river below Goodwin Dam (Kondolf et al. 2001). Evaluations for the Central Valley Flood Protection Plan indicate that the lower Stanislaus River channel capacity is higher than the values shown in Figure 6-3 and Table 6-3.

Table 6-4 shows that the action stage for the Stanislaus River is 8,500 cfs, and that the minor flooding level for the Stanislaus River is 12,500 cfs (NWS n.d.). Table 6-5 shows some local effects that occur at various discharge levels as well as reservoir flow limits for power generation.

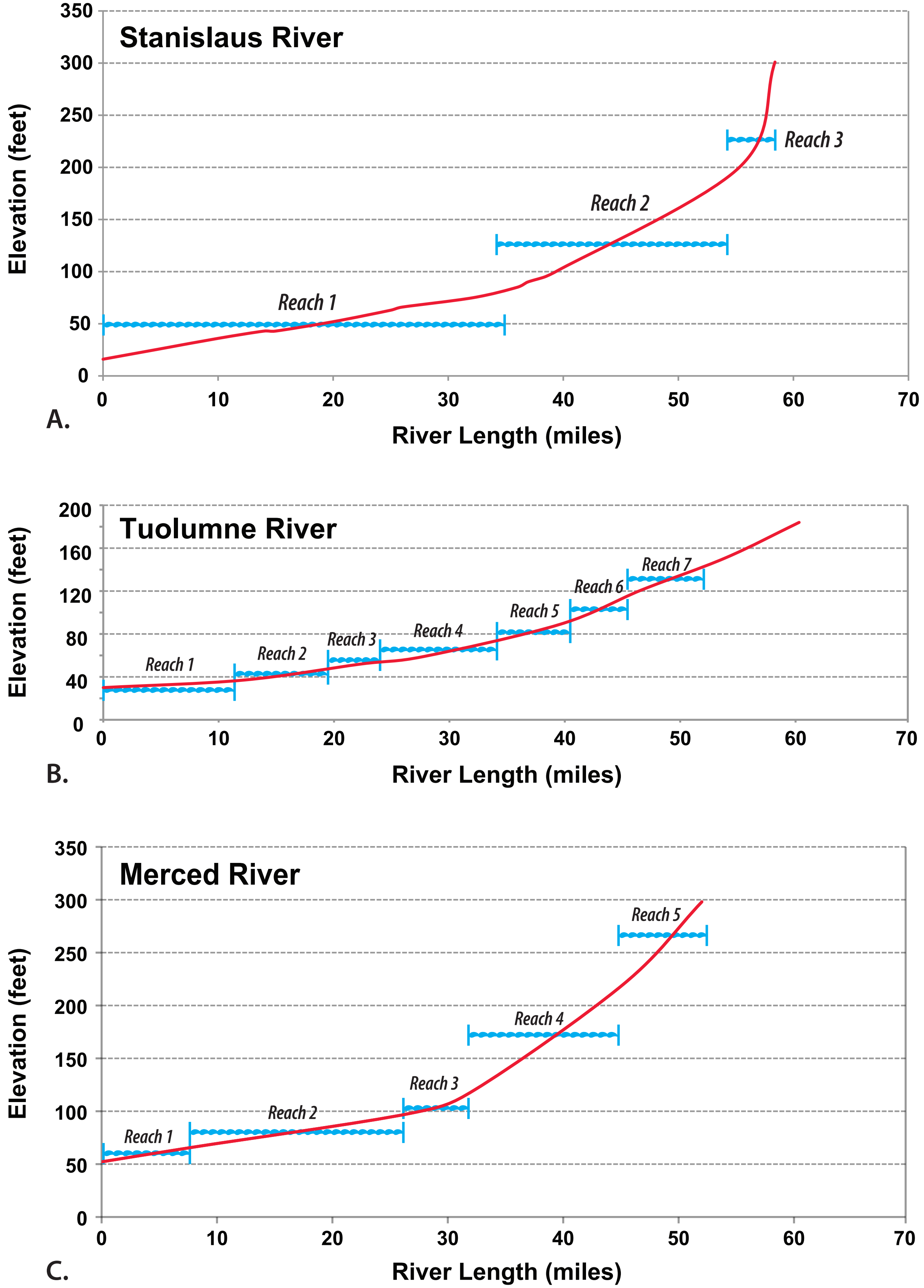

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Figure 6-4
Longitudinal Profiles for
Stanislaus, Tuolumne, and Merced Rivers

Table 6-6. Stanislaus River Channel Reaches

Reach	1	2	3
River Mile	0–34	34–54.75	54.75–58.4
Gradient (%)	0.0004	0.0008	0.0047
Description	Reach below Riverbank composed of Holocene river deposits. Channel meandering begins and becomes more prominent downstream. Sand bedded conditions probably begin below Ripon based on the lower channel gradient and increased meandering. Levees extend from RM 0 to about RM 11 Gravel mining adjacent to river upstream of Ripon (RM 19).	Channel is inset below and confined by older and higher river terraces. Occasional gravel mining and dredger tailings indicating gravel bed conditions. Knights Ferry at RM 54. Oakdale at RM 41. Riverbank at RM 34.	Channel is incised into bedrock and very confined and non-meandering. Gravel bedded. Begins to emerge from bedrock canyon at RM 54.75.

Source: Kondolf et al. 2001
RM = River Mile

Kondolf et al. (2001) also report active channel meandering and potential avulsion at Caswell State Park (approximately RM 4 to RM 9.5). Avulsion occurs when a stream channel leaves its initial channel, flows across the landscape and establishes a new channel position. Depending on landscape condition, the new channel may or may not reconnect with the original channel downstream. Avulsion only occurs during high flows.

The U. S. Fish and Wildlife Service (2012, 2013) is evaluating floodplain fish habitat in relationship to discharge in the Stanislaus River (see detailed discussion in Chapter 19, *Analysis of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, Section 19.3, *Floodplain Inundation*). Current USFWS results indicate that floodplain inundation began at 1,250 cfs in both the Ripon to Jacob Meyers and the Orange Blossom Bridge to Knight's Ferry reaches.

Recent floods were recorded in the region and on the Stanislaus River in 1983, 1986, 1995, 1997, and 2006 (USACE 1999; Parrett and Hunrichs 2006). Generally these flood flows were contained by the channel and adjacent floodplain within the floodway (USACE 1999; DWR 2010, 2011, 2012).

Although the channel capacity is 8,000 cfs, there is agriculture within the floodway that may be affected by seepage and high water tables at flows above 1,500 cfs (McAfee 2000; Kondolf et al. 2001). Concerns about seepage involve potentially adverse impacts that may occur to agricultural crops such as damage to the root systems of tree crops when the groundwater level rises due to high river flows. NMFS Biological Opinion RPA (NMFS 2011) limits spring pulse flow events to <10 days to reduce potential impacts of seepage to orchard crops. The RPA also includes channel forming and maintenance flows in the 3,000- to 5,000-cfs range in above normal and wet years to maintain spawning and rearing habitat quality. These flows are scheduled to occur after March 1 to protect incubating eggs and provide outmigration flow cues. These flows are high intensity, but limited in duration to avoid potential seepage issues that have been alleged under extended periods of flow greater than 1,500 cfs. New Melones flow releases continue to operate in line with these limits (Clinton pers. comm.); however, flows on the Stanislaus are often above 1,500 cfs. The 1,500 cfs restriction does not apply for flood control releases.

The composite condition for the Stanislaus River levees is "higher concern," i.e., the levees display more performance problems than those of lower concern (DWR 2012:Figure 1-7). Detailed levee evaluations for the Central Valley Flood Protection Plan only include the levees immediately upstream of the Stanislaus River–SJR confluence to about RM 2 (DWR 2010, 2011, 2012). The evaluations include numerous criteria that affect levee integrity including seepage, slope stability, erosion, and animal burrows (DWR 2011, 2012). DWR (2011) also includes individual rating maps for each assessment criteria.

Tuolumne River

Similar to other Sierra Nevada tributaries, the Tuolumne River transitions from steeper, gravel-bedded reaches that have been affected by gold dredging and aggregate mining activities to areas where various activities have encroached on the stream channel, and then to a lower gradient sand-bedded reach. The upper gravel-bedded reaches are from RM 24 to RM 52 while the lower sand-bedded reaches are from RM 0 to RM 24. The lower and upper reaches have gradients of approximately 0.0003 to 0.0015, and the lowermost channel is sand-bedded (USACE 2002). Figure 6-4 shows the Tuolumne River longitudinal profile and Table 6-7 describes the seven channel reaches, divided based on characteristics of the river channel, floodplain morphology and alterations to the river channel and floodplain (McBain and Trush 2000).

Under current conditions, gravel transport in the upper reaches are estimated to begin at discharges of 7,050 cfs to 9,800 cfs based on observations and calculations presented in McBain and Trush 2000. USFWS (2010) reports a 1995 Tuolumne River flow of 8,400 cfs. Figure 2-9 (*Monthly Unimpaired and Historical Tuolumne River Flows February–June*) shows that in water years 2000–2009, flows of this level were reached only in water year 2006.

Private levees occur intermittently along the lower ten miles of the Tuolumne River (DWR 2010: Appendix A, Figure 7). The lower Tuolumne River has an estimated channel capacity of approximately 15,000 cfs, which is also the design channel capacity for the entire river (Figure 6-3; Table 6-3).

Table 6-4 shows that the action stage for the Tuolumne River is 6,600 cfs and that the minor flooding level for the Tuolumne River is 10,400 cfs (NWS n.d.). Table 6-5 shows some of the local effects that occur at various discharge levels as well as reservoir flow limits for power generation.

Overbank flow begins at river discharges of 1,100 cfs to 3,200 cfs, based on a USFWS flow-overbank inundation evaluation of the Tuolumne River from RM 21.5 (just upstream of the Santa Fe Bridge near the town of Empire) to the La Grange Dam at RM 52 (USFWS 2010) using river channel aerial photographs from various years with river flows of 100–8,400 cfs, and then plotting river acres inundated versus river flow. These "overbank" flows are not flood flows that inundate the entire floodway capacity; instead they are flows that inundate the adjacent point bars and varying portions of the floodplain (see discussion in Chapter 19, *Analysis of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, Section 19.3, *Floodplain Inundation*). The channel capacity for the Tuolumne River is approximately 15,000 cfs (Figure 6-3 and Table 6-3).

Table 6-7. Tuolumne River Channel Reaches

Reach	1	2	3	4	5	6	7
River Mile	0.0–10.5	10.5–19.3	19.3–24.0	24.0–34.2	34.2–40.3	20.3–46.6	46.6–52.0
Gradient (%)	<0.0003	<0.0003	<0.0003	<0.0003 – 0.0015	0.0010 – 0.0015	0.0010 – 0.0015	0.0010 – 0.0015
Description	Sand-Bedded Agricultural encroachment. No valley confinement during high flow.	Sand-Bedded Agricultural and urban encroachment. Moderate valley confinement. City of Modesto is in reach center. Dry Creek enters about midway.	Sand-Bedded Agricultural and rural encroachment. Low valley confinement. Upstream end is transition to gravel-bedded channel.	Gravel-Bedded In-channel gravel mining occurs with dike encroachments. Agricultural encroachment. Low valley confinement downstream of Waterford.	Gravel-Bedded Extensive off-channel gravel mining pits. Dikes to isolate pits from river. Agricultural encroachment. Low valley confinement.	Gravel-Bedded Remnant gold dredge tailings on floodplain. Fragmented channel with multiple backwaters. Low valley confinement during high flow.	Gravel-Bedded Highest salmon spawning use. Agricultural land use. Low valley confinement during high flow. Single thread meandering low water channel with low bankfull confinement.

Source: McBain & Trush, Inc. 2000.

Recent floods were recorded in the region and on the Tuolumne River in 1983, 1986, 1995, 1997, and 2006 (USACE 1999; Parrett and Hunrichs 2006). Generally these flood flows were contained by the channel and adjacent floodplain within the floodway (USACE 1999). However, the 1997 flood resulted in bank overtopping near Modesto, Waterford, La Grange, and Roberts Ferry (USACE 1999).

Merced River

Similar to other Sierra Nevada tributaries, the Merced River transitions from steeper, gravel-bedded reaches affected by gold dredging and aggregate mining, to areas where various activities have encroached on the stream channel, and then to a lower gradient sand-bedded reach. The lower and upper reaches have gradients of approximately 0.00002 to 0.0023, and the lowermost channel is sand-bedded (USACE 2002). Figure 6-4 shows the Merced River longitudinal profile, and Table 6-8 describes the five channel reach divisions (Stillwater Sciences 2001). These channel reach divisions are based on characteristics of the river channel, floodplain morphology and alterations to the river channel and floodplain.

Table 6-8. Merced River Channel Reaches

Reach	1	2	3	4	5
River Mile	0.0–8.0	8.0–26.8	26.8–32.5	32.5–45.2	45.2–52.0
Gradient (%)	0.0002	0.0003	0.0008	0.0015	0.0023
Description	Confluence Reach Reach entirely sand bedded and subject to backwater effects from SJR. Some meanders are armored, others not.	Encroached Reach Channel bed transitions from gravel to sand. The transition zone extends from RM 25.5 to 16.5. Agricultural development on former floodplain confines the river area between private levees. Channel migration eliminated and channel simplified.	Gravel Mining Reach 2 Reach includes Dry Creek confluence. Channel bed of sand, gravel, and cobble. Channel is incised up to 5 feet. Aggregate mining in channel and on floodplain. Dry Creek contributes large amount of sand.	Gravel Mining Reach 2 Cobble and gravel bedded but subsurface contains significant sand. Channel converted to single-thread channel with floodplain sloughs converted to irrigation ditches and drains. Some remnant off-channel meander channel features remain.	Dredger Tailings Reach Channel and floodplain dredged for gold. Adjacent floodplain raised by dredge piles. Channel converted from complex multi-thread channel to single channel. Agricultural development on floodplain.

Source: Stillwater Sciences 2001.
RM = River Mile

Gravel transport (or bed mobilization) in the upper dredger tailings reach was estimated to occur when flow conditions were greater than 4,800 cfs (Stillwater Sciences, 2001) which was similar to values in Kondolf et al. (1996) for similar sized material. Stillwater Sciences (2004) reports localized and short distance gravel movement (tens of ft) at flows of 1,870 cfs. Recent observations of gravel sediment movement in a restoration reach just above RM 43 (below Snelling, RM 48) show movement at similar discharges.

Harrison et al. (2011) measured discharge, flow characteristics and channel characteristics including changes in bed topography as an indicator of gravel mobility. They found that most of the gravel movement was in the upper 2,625 ft of the 6,645-ft restoration reach. This gravel movement primarily occurred at higher discharges of 4,255 cfs–5,015 cfs. Albertson et al. (2011) estimated more gravel mobility at lower discharges but that mobility does not reflect the observed gravel movement in the restoration reach (Harrison et al. 2011). Figure 2-8 (*Monthly Unimpaired and Historical Merced River Flows February–June*) shows that in water year 2000–water year 2009, flows of this level were reached in water years 2000, 2005, and 2006.

Bank erosion has decreased throughout the Merced River because of reduced peak flows and because of bank protection. About four percent of the channel banks show evidence of erosion, and these tend to alternate with bank protection sites (Stillwater Sciences 2001, Table 12). However, Harrison et al. (2011) evaluated ten meander bends in a restoration reach just above RM 43 and reported average bank erosion rates of 2.3 ft to 8.5 ft per year for the periods of peak flow (water years 2005 and 2006). This bank erosion along the restored channel occurred in the broad dredger tailings area (Figure 6-4, Reach 5) and this bank-floodplain area was specifically designed to allow such bank erosion-channel migration.

Private levees locally reduce floodplain width in reaches 3 and 4, and reach 2 has levees along approximately 60 percent of its length (Stillwater Sciences 2001; DWR 2010, 2011). The Merced River has an estimated channel capacity of approximately 6,000 cfs (Figure 6-3; Table 6-3; Stillwater Sciences 2001).

Table 6-4 shows that the action stage for the Merced River is 3,200 cfs, and that the minor flooding level for the Merced River is 6,900 cfs (NWS n.d.). Table 6-5 shows the reservoir flow limits for power generation. Floodplain inundation on the Merced River is assumed to start at 1,000 cfs (see discussion in Chapter 19, *Analysis of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, Section 19.3, *Floodplain Inundation*).

Recent floods were recorded in the region, with high flows on the Merced River in 1983, 1986, 1995, 1997, 2005, and 2006 (USACE 1999; Parrett and Hunrichs 2006; Albertson et al. 2011; Harrison et al. 2011). These flood flows were contained by the channel and adjacent floodplain within the floodway (USACE 1999).

6.2.3 Extended Plan Area

The Stanislaus, Tuolumne, and Merced rivers originate in the uppermost Sierra Nevada Mountains. The uppermost reaches have been scoured by glaciations so there is abundant exposed bedrock (California Geological Survey 2002). Above the rim dams the rivers generally flow through confined bedrock valleys or steep bedrock gorges (Kondolf et al. 2001; California Geological Survey 2002; Stillwater Sciences 2002). The stream channels are commonly very coarse-grained, especially downstream of dams on the Stanislaus and Tuolumne rivers (e.g., Kondolf et al. 2001). The stream channels also tend to be relatively steep, although the Yosemite Valley floor is very flat (Minear and Wright 2013).

6.3 Regulatory Background

6.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to flood control and geomorphic conditions are described below.

U.S. Army Corps of Engineers Flood Operations

USACE is responsible for prescribing regulations for the use of storage allocated for flood control at certain reservoirs in the plan area. USACE maintains flood operations plans and operating criteria for these reservoirs. Flow criteria are described in Chapter 2, *Water Resources*, in Section 2.4.3, *Flow Requirements*. As described in that section combined Merced River and Dry Creek flows must not exceed 6,000 cfs and Tuolumne River flood control releases cannot exceed 9,000 cfs below Dry Creek. The Stanislaus River cannot exceed 8,000 cfs and the LSJR flow at Vernalis cannot exceed 50,000 cfs.

U.S. Army Corps of Engineers Levee Safety Program

In 2006, the USACE implemented a new Levee Safety Program with a more comprehensive and rigorous levee inspection process to aid in communicating to local sponsors and the public the overall condition of levee systems and to recommend actions to reduce flood risk. The USACE Rehabilitation and Inspection Program provides for rehabilitation and/or repair of certain eligible (active status) levees that are damaged during flood events. This authority covers post flood repair of both federally authorized and/or constructed and non-federally constructed flood control works. Inspections of federal levees are funded and conducted under the Inspection of Completed Works (ICW) program. Inspection of non-federal levees are funded and conducted under the Rehabilitation and Inspection Program. As the subject levees in the LSJR and lowermost Stanislaus River that are within the plan area, are classified as federal levees, inspections are funded and conducted under the ICW program.

6.3.2 State

Relevant state programs, policies, plans, or regulations related to flood control and geomorphic conditions are described below.

Central Valley Flood Protection Board and Central Valley Flood Protection Plan

The California Central Valley Flood Protection Board (CVFPB) (formerly the California Reclamation Board) provides flood management for the Central Valley, including the Sacramento River and SJR and their tributaries. The CVFPB has established standards that apply to encroachments and work that affect authorized flood control projects, floodways, and any adopted plan of flood control. (Cal. Code Regs., tit. 23, §§ 111–138.)

The Central Valley Flood Protection Act of 2008 requires the California Department of Water Resources (DWR) to prepare, and the CVFPB to adopt, the Central Valley Flood Protection Plan (CVFPP) by 2012. The plan, which was adopted in June 2012, is intended to provide a system-wide approach to protecting areas currently protected by facilities of the State Plan of Flood Control. The regional and system improvements considered in the CVFPP are intended to address a number of potential physical threats to the existing flood management system. As described in the CVFPP, cities and counties within the Sacramento–San Joaquin Valley must update their general plans and zoning ordinances within 24 months to include information in the plan, and goals and measures consistent with the plan, to reduce the risk of flood damage.

6.3.3 Regional or Local

Local policies relevant to flood control and geomorphic condition within the three eastside tributaries, LSJR, and the Delta result from implementation of, or compliance with, federal and state requirements.

6.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on flooding, sediment, and erosion. It further describes the methods of analysis used to determine significance. If any significant impacts are identified, measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) them are included in the impact discussion.

6.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Resources Control Board's (State Water Board's) Environmental Checklist in Appendix A of the Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Certain flooding, sediment, and erosion impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis as to whether the alternatives could result in the following:

- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.

In addition, if flooding on- or off-site would occur, the analysis identifies if people or structures would be exposed to a significant risk of loss, injury or death involving flooding. Where appropriate, specific quantitative or qualitative criteria are described in Section 6.4.2, *Methods and Approach*, for evaluating these thresholds.

As described in Appendix B, *State Water Board's Environmental Checklist,* the LSJR and SDWQ alternatives would result in either no impact or less-than-significant impacts on the following related to flooding, sediment, and erosion, and, therefore, are not discussed within this chapter.

- Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map.
- Place within a 100-year flood hazard area structures that would impede or redirect flood flows.
- Expose people or structures to a significant risk of loss, injury or death involving result of the failure of dam.
- Inundation by seiche, tsunami, or mudflow.

In addition, as described in Appendix B, *State Water Board's Environmental Checklist,* the alternatives would result in either no impact or less-than-significant impacts in the following categories related to geology and soils, and, therefore, the following areas are not discussed within this chapter.

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault; strong seismic ground shaking; seismic-related ground failure, including liquefaction; or landslides.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in an on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Result in substantial soil erosion or the loss of topsoil.

6.4.2 Methods and Approach

LSJR Alternatives

This chapter evaluates the potential flooding, sediment, and erosion impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow[3] requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All

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[3] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K. Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects on fisheries, including temperature, which would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.
4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may take place on either a short-term (for example monthly or annually) or longer-term basis. Adaptive implementation is intended to optimize flows to achieve the narrative objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife.

The impact mechanisms for causing sediment transport or erosion and flooding include (1) increasing flows such that they cause substantial additional sediment (gravel and sand) transport or siltation and stream bank erosion (Impact FLO-1), and (2) increasing flows such that they exceed channel capacities and cause flooding outside the levees or floodway (Impact FLO-2). The impact analysis uses results from the State Water Board's WSE monthly model (presented in Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling)*, to assess whether the LSJR alternatives would result in flooding, sediment transport, or erosion. Impacts were assessed by comparing the baseline flow results with the results for LSJR Alternatives 2, 3, and 4. The quantitative results included in the figures, tables, and text of this chapter present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). The impact assessment addresses the expected changes in flows for the LSJR alternatives compared to channel capacities (as identified in Table 6-3). The entire set of WSE results for 1922–2003 was used to assess how frequently the channel capacities were exceeded (Table 6-9). Because exceedances were very rare, the wettest years were examined more thoroughly (Tables 6-10, 6-11, and 6-12).

Table 6-9. Percent of Months with WSE Model Results Greater than Capacity

Alternative	Capacity	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Stanislaus River at Ripon													
Baseline	8,000	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 2	8,000	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 3	8,000	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 4	8,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tuolumne River at Modesto													
Baseline	15,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 2	15,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 3	15,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 4	15,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Merced River at Stevinson													
Baseline	6,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	1.2	0.0	0.0	0.0
LSJR Alternative 2	6,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	1.2	0.0	0.0	0.0
LSJR Alternative 3	6,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	1.2	0.0	0.0	0.0
LSJR Alternative 4	6,000	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.0	1.2	0.0	0.0	0.0
San Joaquin River at Vernalis													
Baseline	52,000	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 2	52,000	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 3	52,000	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSJR Alternative 4	52,000	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6-10. Stanislaus River Peak Monthly Flow and Percent of Channel Capacity by Alternative (Channel Capacity of 8,000 cfs) During Wettest Years

		Baseline		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
Water Year[a]	Feb–Jun Peak Monthly Unimpaired Flow (cfs)	Flow (cfs)	Percent	Flow (cfs)	Percent	Flow (cfs)	Percent	Flow (cfs)	Percent
1938	8,803	1,945	24	2,329	29	3,357	42	5,166	65
1943	5,170	3,456	43	3,456	43	1,826	23	2,819	35
1952	9,595	2,089	26	2,089	26	3,668	46	5,529	69
1956	6,443	1,849	23	1,720	22	2,247	28	3,535	44
1958	9,233	2,023	25	2,023	25	3,481	44	5,329	67
1967	8,243	1,622	20	1,650	21	3,188	40	4,838	60
1969	9,675	2,088	26	2,088	26	3,752	47	5,687	71
1978	6,386	803	10	1,278	16	2,265	28	3,447	43
1980	5,212	2,040	26	2,040	26	2,024	25	2,934	37
1982	7,271	2,993	37	2,993	37	2,766	35	4,222	53
1983	10,627	6,223	78	6,223	78	6,223	78	6,313	79
1984	4,831	5,126	64	5,126	64	5,126	64	5,126	64
1986	9,580	2,960	37	1,916	24	3,832	48	5,747	72
1995	7,878	1,631	20	1,728	22	2,791	35	4,365	55
1997	3,755	10,555	132	10,555	132	10,555	132	6,009	75
1998	8,582	2,214	28	2,214	28	3,035	38	4,752	59

Note: Channel capacity from Table 6-3. Gray cells indicate values above capacity.

cfs = cubic feet per second

[a] These are water years with the highest monthly modeled flow and highest unimpaired annual flow.

Table 6-11. Tuolumne River Peak Monthly Flow and Percent of Channel Capacity by Alternative (Channel Capacity of 15,000 cfs) During Wettest Years

Water Year[a]	Feb–Jun Peak Monthly Unimpaired Flow (cfs)	Baseline		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Flow (cfs)	Percent	Flow (cfs)	Percent	Flow (cfs)	Percent	Flow (cfs)	Percent
1938	11,959	7,992	53	7,992	53	7,992	53	6,739	45
1943	8,043	6,406	43	6,406	43	6,406	43	6,406	43
1952	12,870	5,055	34	5,055	34	5,055	34	7,127	48
1956	9,778	7,146	48	5,679	38	4,963	33	6,985	47
1958	12,383	6,374	42	6,374	42	5,471	36	6,928	46
1967	12,495	6,352	42	6,352	42	6,352	42	6,843	46
1969	15,617	7,110	47	7,110	47	7,110	47	8,816	59
1978	11,143	4,876	33	5,421	36	4,876	33	5,947	40
1980	9,054	6,927	46	6,927	46	6,927	46	6,510	43
1982	11,272	9,332	62	9,332	62	9,332	62	9,332	62
1983	17,077	16,297	109	16,297	109	16,297	109	16,297	109
1984	8,713	7,479	50	7,479	50	7,479	50	7,479	50
1986	11,100	8,232	55	8,232	55	5,902	39	6,567	44
1995	13,627	9,474	63	9,474	63	9,474	63	8,333	56
1997	8,807	17,925	120	17,925	120	17,925	120	17,925	120
1998	14,368	7,440	50	7,010	47	6,614	44	7,976	53

Note: Channel capacity from Table 6-3. Gray cells indicate values above capacity. For all alternatives, no additional rows would be highlighted if a capacity of 10,000 cfs had been used instead of 15,000 cfs (10,000 cfs is the channel capacity through downtown Modesto as indicated by NWS [Table 6-5]).

cfs = cubic feet per second

[a] These are water years with the highest monthly modeled flow and highest unimpaired annual flow.

Table 6-12. Merced River Peak Monthly Flow and Percent of Channel Capacity by Alternative (Channel Capacity of 6,000 cfs) During Wettest Years

Water Year[a]	Feb–Jun Peak Monthly Unimpaired Flow (cfs)	Baseline		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Flow (cfs)	Percent	Flow (cfs)	Percent	Flow (cfs)	Percent	Flow (cfs)	Percent
1938	7,431	4,875	81	4,875	81	4,875	81	4,657	78
1943	4,750	3,022	50	3,022	50	3,022	50	3,022	50
1952	7,242	3,524	59	3,524	59	3,524	59	3,626	60
1956	5,181	2,288	38	3,440	57	3,859	64	4,319	72
1958	6,679	3,409	57	3,409	57	3,409	57	3,391	57
1967	7,191	4,079	68	4,079	68	4,079	68	3,807	63
1969	9,194	5,379	90	5,379	90	5,379	90	5,120	85
1978	6,846	3,832	64	3,589	60	3,140	52	3,381	56
1980	4,854	4,472	75	4,472	75	4,472	75	4,474	75
1982	7,206	4,845	81	4,845	81	4,845	81	4,845	81
1983	11,025	7,273	121	7,273	121	7,273	121	6,535	109
1984	4,304	3,495	58	3,495	58	3,495	58	3,495	58
1986	6,520	4,031	67	4,031	67	4,031	67	3,899	65
1995	7,914	5,050	84	5,050	84	5,050	84	4,726	79
1997	4,516	9,859	164	9,859	164	9,859	164	9,859	164
1998	8,038	5,151	86	5,092	85	4,631	77	4,038	67

Note: Channel capacity from Table 6-3. Gray cells indicate values above capacity.

cfs = cubic feet per second

[a] These are water years with the highest monthly modeled flow and highest unimpaired annual flow.

The LSJR alternatives do not involve physical changes to existing drainage patterns of the site or area, such as habitat restoration, dredging, or floodplain restoration, in a manner that would result in substantial erosion or siltation. The LSJR alternatives do not involve physical changes that substantially alter the existing drainage of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site. Accordingly, because the LSJR alternatives do not involve physical changes to the existing drainage or increases in surface runoff, there are no associated impacts and these issues are not addressed further.

This SED also evaluates whether the LSJR alternatives would substantially alter in-channel sediment transport (erosion) in a manner that would result in substantial erosion or siltation (FLO-1). The information in Tables 6-3 and 6-9 through 6-12 is used to determine if flows under the LSJR alternatives would cause excessive sediment transport and erosion. One intent of the LSJR alternatives is to increase within-channel sediment transport to enhance fish habitat, including spawning habitat. Consequently, some increased transport of gravel, sand and silt are likely to occur; the transport amount would be dependent on the expected flow under a specific alternative. Therefore, the analysis evaluates whether the LSJR alternatives are likely to have significant impacts by eroding stream banks and causing channel instability or levee collapse, or by moving so much sediment that excessive sedimentation (gravel and sand) or siltation (silt) is likely to occur (Impact

FLO-1). Excessive sedimentation is large amounts of sediment that contribute to channel instability or bury aquatic habitat.

This SED also evaluates whether the LSJR alternatives would substantially alter in-channel patterns and sediment transport in a manner that would result in flooding on- or off-site (FLO-2). Flooding is considered to occur at discharges greater than the channel capacities (Table 6-3), since flows greater than the channel capacities would inundate areas outside the levees or floodway (DWR 2010, 2011, 2012). As described in Chapter 3, *Alternatives Description*, the specified minimum unimpaired flow requirement for a particular LSJR alternative would cease to apply when flows would exceed levels that would cause or contribute to flooding or other related public safety concerns. The State Water Board would consult with appropriate federal, state and local agencies, including the reservoir operators, USBR, and USACE, in making its determination whether the specified minimum unimpaired flow requirements would apply. The NWS action stage of the rivers, i.e., the point on a rising stream at which some type of action should be taken in preparation for possible significant hydrologic activity (e.g., preventing access to or evacuating low-lying areas adjacent to a river), is a reasonable proxy for the purposes of this SED analysis to describe the flows above which the unimpaired flow requirements may not apply as a result of public safety concerns (Impact FLO-2). Action stages for each river are identified in Table 6-4, and are generally considerably lower than the estimated channel capacity.

This chapter also incorporates a qualitative discussion of adaptive implementation under each of the LSJR alternatives that includes the potential environmental effects associated with adaptive implementation. To inform the qualitative discussion and account for the variability allowed by adaptive implementation, modeling was performed to predict conditions at 30 percent and 50 percent of unimpaired flow (as reported in Appendix F.1). The modeling also allows some inflows to be retained in the reservoirs until after June, as could occur under method 3, to prevent adverse temperature effects. This variety of modeling scenarios provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. This chapter incorporates a qualitative discussion of the potential flooding, sediment, and erosion impacts of adaptive implementation under each of the LSJR alternatives. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

The Stanislaus River has experienced seepage in some locations where agricultural production occurs at flows greater than 1,500 cfs. Therefore, the WSE model was used to calculate the percentage of monthly flows greater than 1,500 cfs under baseline and compared to the LSJR alternatives. Tables 6-13 and 6-14 show that under baseline, flows greater than 1,500 cfs occur at Goodwin and Ripon 27 and 28 percent of the time, respectively, in March; 46 and 52 percent of the time, respectively, in April; and 40 and 43 percent of the time, respectively, in May. This information is used to evaluate effects on stream bank erosion on the Stanislaus River in Impact FLO-1. Note that this seepage has not resulted in surface inundation (flooding). The impacts associated with underseepage on agricultural production are addressed in Chapter 11, *Agricultural Resources*.

Table 6-13. Percentage of Monthly Flows Greater than 1,500 cfs, Stanislaus River at Goodwin

Month/ Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average Percent
Baseline	1	2	2	6	7	29	43	40	5	1	2	4	11
LSJR Alternative 2	1	2	4	7	10	33	34	33	2	1	5	5	11
LSJR Alternative 3	0	2	2	6	10	26	41	57	13	1	1	2	13
LSJR Alternative 4	0	1	1	4	21	29	65	76	39	1	0	1	19

cfs = cubic feet per second

Table 6-14. Percentage of Monthly Flows Greater Than 1,500 cfs, Stanislaus River at Ripon

Month/ Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average Percent
Baseline	2	2	2	7	7	29	54	44	17	1	2	4	14
LSJR Alternative 2	2	2	4	7	10	33	50	40	12	1	5	6	14
LSJR Alternative 3	1	2	2	6	13	28	56	65	24	1	1	2	16
LSJR Alternative 4	1	1	1	4	22	29	73	83	51	2	1	1	22

cfs = cubic feet per second

Flood Control Operations at the Reservoirs

The same flood control curves and daily operations would be used for actual operations of the three reservoirs under the LSJR alternatives as under the baseline. Although the monthly reservoir operations during the February–June period would be slightly different under the LSJR alternatives, the same end of month flood control storage space rules would apply and the same need for daily flood control releases would apply during major rainfall runoff events. Some of the LSJR alternatives would release more water than the baseline earlier in the year, and the storage would be reduced so that flood control releases that might have occurred under baseline conditions would be delayed and/or reduced. The daily releases could vary between the LSJR alternatives, but in general the maximum flood control release would not be increased. Therefore, periodic high flood flows during major storms on each of the three eastside tributaries would be nearly the same as the flood control releases under baseline.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, and Appendix B, *State Water Board's Environmental Checklist*, the baseline water quality in the southern Delta generally ranges from 0.2 dS/m and 1.2 dS/m during all months of the year. There is a strong relationship between salinity at Vernalis and salinity in the southern Delta, which generally increases by a maximum of 0.2 dS/m above the Vernalis salinity. Seasonal and inter-annual fluctuations in salinity in the southern Delta as a result of SDWQ Alternatives 2 or 3 are expected to be similar to historic fluctuations because the USBR's water rights would continue to be conditioned to meet the existing Vernalis electrical conductivity (EC)[4] requirement in through the program of implementation, thereby maintaining flows. Therefore, they are not discussed further in this chapter. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on biological resources. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

6.4.3 Impacts and Mitigation Measures

Impact FLO-1: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan). See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

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[4] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

LSJR Alternatives

Sediment (gravel and sand) transport can undermine stream banks or levees, thus potentially altering the existing drainage patterns. The transport of gravel and sand and the effect on stream bank or levee stability typically occur at higher flows generally either near channel capacities or exceeding channel capacities; therefore, they are discussed together in the impact analysis below. Silt materials are more easily transported than gravel and sand and silt transport does not influence stream bank or levee stability. However, excessive silt erosion and transport could alter the existing drainage pattern of a site by causing excessive siltation within fish spawning gravels or elsewhere; therefore, it is discussed separately from gravel and sand transport in the impact analysis below.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Gravel and Sand Erosion

The amount of sediment transport and bank erosion under LSJR Alternative 2 would be similar to existing conditions. Sediment transport and erosion would be restricted by flood control activities, existing action stages, and existing bank armoring on the rivers. Consequently, no significant impact would occur with respect to the amount of sand and gravel transported, or bank erosion. Similarly, although there are identified levee stability issues along the LSJR and within the Delta (DWR 2010, 2011, 2012), the expected amount of gravel and sand transported under LSJR Alternative 2 would not be large enough to contribute to levee instability.

The existing stream channels transport the coarsest sediment at flows near channel capacities or exceeding channel capacities. The flows associated with LSJR Alternative 2, even when cumulated downstream from each of the eastside tributaries, are almost always substantially lower than the channel capacities in these river reaches and the Delta (Table 6-3 and Figure 6-3). Therefore, the amount of coarse sediment transported at higher flows would be limited under LSJR Alternative 2.

The range of flows associated with LSJR Alternative 2 is similar to flows that occur under baseline conditions. Only two of the water years simulated by the WSE model, 1983 and 1997, had monthly flows that exceeded channel capacities on the Stanislaus, Tuolumne, or Merced Rivers or the SJR (Table 6-9). These exceedances, which resulted from large storm events that led to flood control releases, also occurred under baseline conditions. Therefore, the amount of coarse sediment transported at higher flows under LSJR Alternative 2 is expected to be similar to baseline conditions.

Tables 6-10, 6-11, and 6-12 show the monthly peak flows from the WSE modeling results for the three eastside tributaries during the wettest years and the percent of channel capacity for each flow based on Table 6-3 and Figure 6-3. These peak flood control flows are the flows that are most likely to transport coarse sediment and cause substantial erosion. Under LSJR Alternative 2, peak monthly flows in the three eastside tributaries would be similar to baseline peak flows because they result from flood control actions. Therefore, the monthly releases simulated by the WSE model for meeting the unimpaired flow objectives generally equaled or remained below the baseline peak monthly flood control releases and would not transport any more gravel and sand than is currently transported. The cumulative flow additions from the three eastside tributaries to the LSJR are substantially below its channel capacity, which ranges between 37,000 cfs and 52,000 cfs (Figure 6-3; Tables 6-10, 6-11, 6-12). These small flow additions would not increase coarse sediment transport in the LSJR.

The monthly peak flows from the WSE model would not exceed the action stage, which is lower than the channel capacity (Table 6-4), further restricting sediment transport and erosion under LSJR Alternative 2. There may be circumstances in which the specified minimum unimpaired flow requirement would not apply when flows would exceed levels that would cause or contribute to flooding or other related public safety concerns; however, the decisions regarding these flow levels would vary by river and would involve consultation between the State Water Board and appropriate federal, state, and local agencies as described in Section 6.4.2, *Methods and Approach*.

Varying amounts of bank armoring to reduce stream bank erodibility also occur along the three eastside tributaries (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001). This bank armoring further limits the potential bank erosion under higher baseline flows and flows under LSJR Alternative 2.

Excessive seepage could undermine the riverbank, which has the potential to cause localized stream bank erosion. However, this type of seepage would not result in surface inundation. There have been documented seepage concerns on the Stanislaus River. On the Stanislaus River for flows greater than 1,500 cfs, Tables 6-13 and 6-14 show little change under LSJR Alternative 2, both on a month-by-month and overall average basis. The volume and rate of the resulting seepage would not be sufficient to transport sediment or particles; hence, would not have any effect on stream bank erosion. Furthermore, the flows themselves are not sufficient to cause additional erosion (i.e., flows that cause erosion are known to occur above 3,000 or 4,000 cfs).

Given the range of flows expected under LSJR Alternative 2, existing channel capacities, action stages, and bank armoring, impacts related to sediment transport or bank erosion would be less than significant.

Siltation

With respect to siltation (the deposition of suspended sediment or turbidity), the effects of LSJR Alternative 2 would be generally similar to those discussed above for gravel and sand erosion and be similar to baseline conditions. Higher flows, when they do occur, would transport larger amounts of fine sediment in suspension. Under LSJR Alternative 2, peak flows in the three eastside tributaries would be similar to baseline peak flows because those peak flows result from flood control actions. Therefore, LSJR Alternative 2 would not cause substantial siltation within the eastside tributaries or the LSJR. Consequently, impacts would be less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20 percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20 percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. For example, an increase of up to 30 percent unimpaired flow would generally result in an increase in the volume of water in the rivers than would occur under 20 percent of unimpaired flow at those times of increased releases/flows. But as discussed above, peak flows are associated with flood control releases, not releases to meet LSJR Alternative 2 requirements, and are not expected to substantially change. In addition, it is expected flows would remain in channel capacities with a potential increase in the specified unimpaired flow requirement from 20 percent to 30 percent. Thus, adaptive implementation method 1 would not result in a substantial increase in erosion or siltation.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June time frame. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Changes in the timing of flows released from February–June adaptive implementation method 2 would not exceed peak flows experienced under baseline conditions, and therefore would not substantially result in increased erosion or siltation compared to baseline. In addition, during big storm events, the full specified percent unimpaired flow would not apply when projected flows under LSJR Alternative 2 would exceed levels that would cause or contribute to flooding or other related public safety concerns and therefore a substantial increase erosion or siltation would not occur relative to baseline.

Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent; therefore, adaptive implementation method 3 would not affect erosion or siltation.

Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. The WSE model results show that under LSJR Alternative 2 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 2.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required 0.7 percent of the time to meet a 1,000-cfs requirement and 0.5 percent of the time for an 800-cfs Vernalis base flow requirement. These results indicate that changes due to adaptive implementation method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR.

Impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3. With method 1, if the specified percent of unimpaired flow were changed from 20 percent to 30 percent on a long-term basis, the conditions and impacts could become more similar to those described under LSJR Alternative 3. It is anticipated that over time the unimpaired flow requirement could increase or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. If adaptive implementation method 2 is implemented, the total annual volume of water associated with LJSR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change, but the timing or magnitude of flows might change. However, since monthly peak flows would not be substantially different than baseline, and flows would remain within channel capacities, the potential for additional erosion or siltation effects is similar to the results presented above for LSJR Alternative 2 without adaptive implementation. Implementing method 4 is expected to have little effect on conditions in the three eastside tributary rivers and LSJR because it rarely would cause a change in flow and the volume of water involved would be relatively small. Consequently the impact determination of LSJR Alternative 2 with adaptive implementation would be the same as described for LSJR Alternative 2 without adaptive implementation for erosion and siltation. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Gravel and Sand Erosion

The range of flows associated with LSJR Alternative 3 is similar to flows that occur under baseline conditions. Sediment transport and erosion would be restricted by flood control activities, existing action stages, and existing bank armoring on the rivers. Consequently, no significant impact would occur with respect to sediment transport or bank erosion. Similarly, although there are a variety of levee stability issues identified along the LSJR and Delta (DWR 2010, 2011, 2012), the expected amount of gravel and sand transported is not large enough to contribute to levee instability.

The existing stream channels transport the most coarse sediment) at higher flows. The flows associated with LSJR Alternative 3, even when cumulated downstream from each of the three eastside tributaries, are almost always substantially lower than the channel capacities in these river reaches and the southern Delta (Table 6-3 and Figure 6-3). This result applies even considering the lower channel capacity estimates from DWR for some reaches (2011, Table 6-3). Therefore, the amount of coarse sediment transported at higher flows would generally be limited under LSJR Alternative 3.

The range of flows associated with LSJR Alternative 3 would be similar to flows that occur under baseline conditions. Only two of the water years simulated by the WSE model, 1983 and 1997, had monthly flows that exceeded channel capacities on the Stanislaus, Tuolumne, and Merced Rivers or the SJR (Table 6-9). These exceedances, which resulted from large storm events that led to flood control releases, also occurred under baseline conditions. Therefore, the amount of gravel transported at higher flows under LSJR Alternative 3 is expected to be similar to baseline conditions.

Tables 6-10, 6-11, and 6-12 show the monthly peak flows from the WSE model results for the three eastside tributaries during the wettest years and show the percent of channel capacity for each flow based on Table 6-3 and Figure 6-3. The cumulative flow additions from the three eastside tributaries to the LSJR are substantially below its channel capacity, which ranges between 37,000 cfs and 52,000 cfs (Figure 6-3; Tables 6-10, 6-11, 6-12). These small flow additions would not increase coarse sediment transport in the LSJR. Under LSJR Alternative 3 peak monthly flows in the three eastside tributaries would seldom be sufficient to cause gravel transport in the upper gravel-bedded reaches (i.e., minimum flows in the range of 5,000–8,000 cfs [Stanislaus River], 7,000–9,800 cfs [Tuolumne River], and 4,800 cfs [Merced River]) and in-stream bank erosion. Additionally, the action stage is lower than the gravel transport flow levels in the Tuolumne River (6,600 cfs) and Merced River (3,200 cfs), thus actions to reduce flood risk under high flow conditions would also limit potential gravel transport. For the Stanislaus River the action stage coincides with flow levels that would allow gravel transport to occur. These high flow levels on the three eastside rivers would primarily be associated with peak flows during storm events under LSJR Alternative 3; therefore, they would generate a relatively small amount of stream bank erosion due to their low frequency of occurrence. Furthermore, any gravel movement that would occur is known to be beneficial for aquatic habitat enhancement (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001, 2004). Chapter 7, *Aquatic Biological Resources*, includes a discussion of the importance of gravel transport for fish habitat maintenance.

As discussed under LSJR Alternative 2, varying amounts of bank armoring also occur along the three eastside tributaries. This further limits the potential for bank erosion to occur (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001).

Sand transport begins at relatively low flows so that in the mid- to lower sand-bedded portions of the three eastside tributaries, flows greater than 2,000–3,000 cfs would increase sand movement (Hickin n.d.). However, the largest total amount of sand transport is associated with moderate to peak flows (Wolman and Leopold 1960), and the LSJR Alternative 3 flows would generate a small amount of total additional sand movement, which would be considered less than significant. Furthermore, any sand movement that would occur is known to be a contributing factor to the amount and diversity of aquatic habitat in these reaches and would be considered an enhancement to the aquatic habitat environment (Chapter 7, *Aquatic Biological Resources*).

Excessive seepage could undermine the riverbank, which has the potential causing localized stream bank erosion. This type of seepage would not result in surface inundation. There have been documented seepage concerns on the Stanislaus River. On the Stanislaus River for flows greater than 1,500 cfs, Tables 6-13 and 6-14 show that under LSJR Alternative 3, some months would have decreases in the frequency of flows above 1,500 cfs and some would have increases compared to baseline, but on average there would be moderate increases. As simulated by the WSE model, the overall average percent of months with flow greater than 1,500 cfs would increase by 1 percent at Goodwin and 2 percent at Ripon under LSJR Alternative 3, with the largest increases occurring May–June. These flows may cause localized underseepage to adjacent agricultural lands based on historical accounts. The associated seepage would not have an effect on stream bank erosion because the expected volume and rate of the seepage would not be sufficient to transport sediment or particles. Furthermore, the flows themselves are not sufficient to cause additional erosion (i.e., flows that cause erosion are known to occur above 3,000 or 4,000 cfs).

Given the range of flows expected under LSJR Alternative 3, existing channel capacities, action stages, and bank armoring, impacts related to sediment transport or bank erosion would be less than significant.

Siltation

With respect to siltation (deposition of suspended sediment or turbidity) the effects of LSJR Alternative 3 would be generally similar to those discussed above for gravel and sand transport and erosion. Peak monthly flows are not expected to change significantly compared to baseline conditions. Infrequent high flows would transport larger amounts of fine sediment in suspension than under lower flows. Therefore, LSJR Alternative 3 would not result in substantial siltation within the three eastside tributaries or the SJR. Consequently, impacts would be less than significant.

Adaptive Implementation

Under LSJR Alternative 3, impacts associated with adaptive implementation method 1 may be slightly different from those associated with adaptive implementation methods 2 and 3.

Implementing method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40 percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. Adaptive implementation method 1 could affect the amount of water available for water supply and the volume of water and level of flow in the LSJR and its tributaries. However, the frequency and duration of such a change is unknown. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively. It is anticipated that over time the unimpaired flow requirement could increase, decrease, or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. As described in LSJR Alternatives 2 and 3, a change to the percent of unimpaired flow could affect the volume of water and level of flow in the LSJR and its tributaries; however, peak flows and flood control actions are not expected to change substantially under this range of unimpaired flows.

Under adaptive implementation methods 2 or 3, the overall volume of water from the February–June time period or after June would be the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. Impacts associated with the total volume of water would not be affected by method 2 or 3, but sediment and erosion, which can be dependent on the timing or magnitude of flow, could potentially be affected. Although, the volume of water would be substantially greater in the eastside tributary rivers when compared to baseline conditions, the peak monthly flows would not be substantially different compared to baseline. Similarly, the water volumes that might be shifted under adaptive implementation methods 2 and 3 are small in comparison to peak monthly flows and the effects on sediment and erosion would be small. In addition, adaptive implementation method 3, which allows flow shifting from the February–June time frame to other times of year is incorporated into the modeling; thus, the range of erosion and siltation effects is reflected in the results presented above for LSJR Alternative 3. Finally, given that these two methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described for LSJR Alternative 3 without adaptive implementation.

Implementing method 4 is expected to have little effect on conditions in the three eastside tributary rivers. The WSE model results show that under Alternative 3 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 1.2 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required only 0.2 percent of the time to meet either a 1,000-cfs or 800-cfs Vernalis base flow requirement. These results indicate that method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative.

Consequently the impact determination of LSJR Alternative 3 with adaptive implementation would be the same as described for LSJR Alternative 3 without adaptive implementation, for erosion and siltation. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Gravel and Sand Erosion

The range of flows associated with LSJR Alternative 4 is similar to flows that occur under baseline conditions. Sediment transport and erosion would be restricted by flood control activities, existing action stages, and existing bank armoring on the rivers. Consequently, no significant impact would occur with respect to sediment transport or bank erosion-. Similarly, although there are a variety of levee stability issues identified along the LSJR and Delta (DWR 2010, 2011, 2012), the expected amount of gravel transport is not large enough to contribute to levee instability.

The existing stream channels transport the coarsest sediment at higher flows. The flows associated with LSJR Alternative 4, even when cumulated downstream from each of the eastside tributaries, are almost always substantially lower than the channel capacities in these river reaches and the southern Delta (Table 6-3 and Figure 6-3). This result applies even considering the lower channel capacity estimates from DWR for some reaches (2011, Table 6-3). Therefore, the amount of coarse sediment transported at higher flows would generally be limited under LSJR Alternative 4.

The range of flows associated with LSJR Alternative 4 would be similar to flows that occur under baseline conditions. Only two of the water years simulated by the WSE model, 1983 and 1997, had monthly peak flows that exceeded channel capacities on the Stanislaus, Tuolumne or Merced Rivers or the SJR (Table 6-9). These exceedances, which resulted from large storm events that led to flood control releases, also occurred under baseline conditions as well as under LSJR Alternative 4, with the exception of the January 1997 exceedance on the Stanislaus River. This exceedance occurred only in the baseline modeling results and not the LSJR Alternative 4 results, due to lower reservoir storage in LSJR Alternative 4, which led to lower required flow releases at the time.

Tables 6-10, 6-11, and 6-12 show the monthly peak flows from the WSE model results for the three eastside tributaries during the wettest years and show the percent of channel capacity for each flow based on Table 6-3 and Figure 6-3. The cumulative flow additions from the three eastside tributaries to the LSJR are substantially below its channel capacity, which ranges between 37,000 cfs and 52,000 cfs (Figure 6-3; Tables 6-10, 6-11, 6-12). These small flow additions would not increase coarse sediment transport in the LSJR. The peak flows in the three eastside tributaries would occasionally be sufficient to cause gravel transport in the upper gravel-bedded reaches (i.e., minimum flows in the range of 5,000–8,000 cfs [Stanislaus River], 7,000–9,800 cfs [Tuolumne River] and 4,800 cfs [Merced River]) and some in-stream bank erosion. Additionally, the stage actions are lower than the gravel transport flow levels in the Tuolumne River (6,600 cfs) and Merced River (3,200 cfs). Thus actions to reduce flood risk under high flow conditions would also limit potential gravel transport. For the Stanislaus River the action stage would allow gravel transport to occur. These high flow levels on the three eastside tributaries would primarily be associated with peak flows during storm events under LSJR Alternative 4; therefore, they would generate a relatively small amount of stream bank erosion due to their low frequency of occurrence. Furthermore, any gravel movement that would occur is known to be beneficial for aquatic habitat enhancement (Chapter 7, *Aquatic Biological Resources*; McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001, 2004).

As discussed under LSJR Alternative 2, varying amounts of bank armoring also occur along the three eastside tributaries. This further limits the potential for bank erosion to occur (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001).

Sand transport begins at relatively low flows so that in the mid- to lower sand-bedded portions of the three eastside tributaries, flows greater than 2,000–3,000 cfs would increase sand movement (Hickin n.d.). However, the largest total amount of sand transport is associated with moderate to peak flows (Wolman and Miller 1960), and the LSJR Alternative 2 flows would generate a small amount of total additional sand movement, which would be considered less than significant. Furthermore, this movement is known to be a contributing factor to the amount and diversity of aquatic habitat in these reaches and would be considered an enhancement to the aquatic habitat environment (Chapter 7, *Aquatic Biological Resources*).

Excessive seepage could undermine the riverbank, which has the potential causing localized stream bank erosion. This type of seepage does not result in surface inundation. There have been documented seepage concerns on the Stanislaus River. On the Stanislaus River for flows greater than 1,500 cfs, Tables 6-13 and 6-14 show that under LSJR Alternative 4, some months would have decreases in the frequency of flows above 1,500 cfs and some would have increases compared to baseline, but on average there would be moderate increases. As simulated by the WSE model, the overall average percent of months with flow greater than 1,500 cfs would increase by 7 percent at Goodwin and 8 percent at Ripon under LSJR Alternative 4, with the largest increases occurring April–June. These flows may cause localized underseepage to adjacent agricultural lands. The associated seepage would not have an effect on stream bank erosion because the volume and rate of water expected would not be sufficient to transport sediment or particles. Furthermore, the flows themselves are not sufficient to cause additional erosion (i.e., flows that cause erosion are known to occur above 3,000 or 4,000 cfs).

Given the range of flows expected under LSJR Alternative 4, existing channel capacities, action stages, and bank armoring, impacts related to sediment transport or bank erosion would be less than significant.

Siltation

With respect to siltation (desposition of suspended sediment or turbidity), the effects of LSJR Alternative 4 would be generally similar to those discussed above for gravel and sand transport or erosion Peak monthly flows are not expected to change significantly compared to baseline conditions. Infrequent high flows would transport larger amounts of fine sediment in suspension than under lower flow conditions. Therefore, LSJR Alternative 4 would not result in substantial siltation within the three eastside tributaries or the SJR. Consequently, impacts would be less than significant.

Adaptive Implementation

Under LSJR Alternative 4, impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the annual February–June 60 percent unimpaired flow (to 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3. It is anticipated that over time the unimpaired flow requirement could decrease or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology.

Adaptive implementation method 2 or 3 would shift the timing of the river flows within the February–June time frame or after June. This adaptive implementation method would not affect the total volume of water, but as described above for LSJR Alternative 3, adjustments in the timing or magnitude of the flows could affect erosion and sedimentation. Although the volume of water would be substantially greater in the eastside tributary rivers when compared to baseline conditions, the peak monthly flows would not be substantially different compared to baseline. In addition, given that these two methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described for LSJR Alternative 3 without adaptive implementation.

Implementing method 4 is expected to have little effect on conditions in the three eastside tributary rivers and LSJR. The WSE model results show that under Alternative 4 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 0.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required only 0.2 percent of the time to meet a 1,000-cfs requirement and is not affected at all for an 800-cfs requirement. These results indicate that method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative.

Consequently the impact determination of LSJR Alternative 4 with adaptive implementation would be the same as described for LSJR Alternative 4 without adaptive implementation for erosion and siltation. Impacts would be less than significant.

Impact FLO-2: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

LSJR Alternative 2 has the potential to affect the management of reservoir releases from the rim dams into the three eastside tributaries. Peak monthly flows are not expected to change substantially under LSJR Alternative 2. Only two of the water years simulated by the WSE model, 1983 and 1997, had monthly flows that exceeded channel capacities on the Stanislaus, Tuolumne or Merced Rivers or the LSJR (Table 6-9). These exceedances, which resulted from flood control releases due to large storm events, occurred under baseline conditions as well as under LSJR Alternative 2. Tables 6-10, 6-11, and 6-12 show the monthly peak flows from the WSE modeling results for the three eastside tributaries during the wettest years. These tables also show the percent of channel capacity for each flow based on Table 6-3 and Figure 6-3. Peak monthly flows under LSJR Alternative 2 are not expected to change, and generally remain within the channel capacity for the three eastside tributaries.

Since the flow objectives would generally not affect flood control storage capacity, as flood flow releases would still be made, and would not affect the USACE flood reservation, there would not be any changes in flood control operation procedures during major flood events. Under LSJR

Alternative 2, for most months, monthly median flows for the Stanislaus, Tuolumne, and Merced Rivers and the LSJR do not vary substantially from the modeled baseline median monthly flows (Tables 5-17a). Additionally, the peak monthly flow resulted from the WSE model would not exceed the action stage (Table 6-4) and would not apply when flows would exceed levels that would cause or contribute to flooding or other related public safety concerns as described in Section 6.4.2, *Methods and Approach*. This would further limit flooding under LSJR Alternative 2. LSJR Alternative 2 would not substantially alter existing drainage patterns or substantially increase the rate or amount of surface runoff in a manner that would result in flooding. Consequently, LSJR Alternative 2 would not expose people or structures to a significant risk of loss, injury or death involving flooding as noted in Section 6.4.1, *Thresholds of Significance*.

Adaptive Implementation

Adaptive implementation methods 1, 2, and 4 are not anticipated to substantially alter existing drainage patterns or substantially increase the rate or amount of surface runoff in a manner that would result in flooding. As described in Impact FLO-1, peak flows associated with flood control are not expected to substantially change. Thus, with a potential increase in the specified unimpaired flow requirement from 20 percent to 30 percent (i.e., method 1), it is expected flows would remain in channel capacities. A shift in timing or magnitude of flows under methods 2 is not expected to alter existing drainage patterns or substantially increase the rate or amount of surface runoff because the water volumes that might be shifted under these methods are small in comparison to peak monthly flows and the effects on sediment and erosion would be small. Therefore, impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

LSJR Alternative 3 has the potential to affect management of reservoir releases from the rim dams into the three eastside tributaries. Peak monthly flows are not expected to change substantially under LSJR Alternative 3. Only two of the water years simulated by the WSE model, 1983 and 1997, had monthly flows that exceeded channel capacities on the Stanislaus, Tuolumne and Merced Rivers or the SJR (Table 6-9). These exceedances, which resulted from flood control releases due to large storm events, occurred under baseline conditions as well as under LSJR Alternative 3. Tables 6-10, 6-11, and 6-12 show the monthly peak flows from the WSE modeling results for the three eastside tributaries during the wettest years. These tables also show the percent of channel capacity for each flow based on Table 6-3 and Figure 6-3.

For the LSJR, the Delta, and the three eastside tributaries, the LSJR Alternative 3 flows are almost always substantially lower than the channel capacities in these river reaches and the southern Delta (Table 6-3 and Figure 6-3, and Tables 6-10, 6-11, and 6-12), even when considering the lower channel capacity estimates from DWR for some reaches (2011, Table 6-3). Since these channels are capable of carrying much higher flows, these flows would be contained within the existing floodway, and no significant impact would occur with respect to flooding. Furthermore, because the flow objectives would generally not affect flood control storage capacity, since flood flow releases would still be made, and would not affect the USACE flood reservation, there would not be any changes in flood control operation procedures during major flood events. Additionally, the peak monthly flows would not exceed the action stage (Table 6-4)and would not apply when flows would exceed levels that would cause or contribute to flooding or other related public safety concerns, as described in Section 6.4.2, *Methods and Approach*. This would further limit flooding under LSJR Alternative 3.

LSJR Alternative 3 would not substantially alter existing drainage patterns or substantially increase the rate or amount of surface runoff in a manner that would result in flooding. Consequently, LSJR Alternative 3 would not expose people or structures to a significant risk of loss, injury or death involving flooding as noted in Section 6.4.1, *Thresholds of Significance*.

Adaptive Implementation

Adaptive implementation methods 1, 2, 3, and 4 are not anticipated to substantially alter the existing drainage pattern or increase the rate of surface runoff in a manner that would result in flooding. As described in Impact FLO-1, peak flows associated with flood control are not expected to substantially change. Thus, with a potential increase or decrease in the specified unimpaired flow requirement from 40 percent to either 30 percent or 50 percent (i.e., method 1), it is expected flows would remain in channel capacities. Similarly, a shift in timing or magnitude of flows under methods 2 or 3 is not expected to alter existing drainage patterns or substantially increase the rate or amount of surface runoff because the water volumes that might be shifted under these methods are small in comparison to peak monthly flows and the effects on sediment and erosion would be small. Therefore, impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

LSJR Alternative 4 has the potential to affect management of reservoir releases from the rim dams into the three eastside tributaries. Peak monthly flows are not expected to change under LSJR Alternative 4. Only two of the water years simulated by the WSE model, 1983 and 1997, had monthly flows that exceeded channel capacities on the Stanislaus, Tuolumne or Merced Rivers or the SJR (Table 6-9). These exceedances, which resulted from flood control releases during large storm events, occurred under baseline conditions as well as under LSJR Alternative 4, with the exception of the January 1997 exceedance on the Stanislaus River. This exceedance occurred only in the baseline modeling results and not the LSJR Alternative 4 results (due to lower reservoir storage in LSJR Alternative 4). Tables 6-10, 6-11, and 6-12 show the monthly peak flows from the WSE modeling results for the three eastside tributaries during the wettest years. These tables also show the percent of channel capacity for each flow based on Table 6-3 and Figure 6-3.

For the LSJR, the southern Delta, and the three eastside tributaries, the LSJR Alternative 4 flows are almost always substantially lower than the channel capacities in these river reaches and the southern Delta (Table 6-3, Figure 6-3, and Tables 6-10, 6-11, and 6-12), even considering the lower channel capacity estimates from DWR for some reaches (2011, Table 6-3). Since these channels are capable of carrying much higher flows, these flows would be contained within the existing floodway, and no significant impact would occur with respect to flooding. Furthermore, because the flow objectives would cause minimal changes to storage, and would maintain the USACE flood reservation, there would not be any changes in flood control operation procedures during major flood events. Additionally, the peak monthly flow resulted from the WSE model would not exceed the action stage (Table 6-4) and would not apply when flows would exceed levels that would cause or contribute to flooding or other related public safety concerns, as described in Section 6.4.2, *Methods and Approach*. This would further limit flooding under LSJR Alternative 4. LSJR Alternative 4 would not substantially alter existing drainage patterns or substantially increase the rate of surface runoff in a manner that would directly result in flooding. Consequently, LSJR Alternative 4 would not expose people or structures to a significant risk of loss, injury or death involving flooding as noted in Section 6.4.1, *Thresholds of Significance*.

Adaptive Implementation

Adaptive implementation methods 1, 2, 3, and 4 are not anticipated to result in flooding. As described in Impact FLO-1, peak flows associated with flood control are not expected to substantially change. Thus, with a potential decrease in the specified minimum unimpaired flow requirement from 60 percent to 50 percent (i.e., method 1), it is expected flows would remain in channel capacities. A shift in timing or magnitude of flows under methods 2 or 3 is not expected to alter existing drainage patterns or substantially increase the rate or amount of surface runoff because the water volumes that might be shifted under these methods are small in comparison to peak monthly flows and the effects on sediment and erosion would be small. Therefore, impacts would be less than significant.

6.4.4 Impacts and Mitigation Measures: Extended Plan Area

The types of impacts that could occur in the extended plan area with respect to flooding, sediment, and erosion are similar to those described and discussed for the plan area. In general, upstream reservoirs would have more storage capacity under LSJR Alternatives 2, 3, or 4 with or without adaptive implementation because flows would be bypassed so there would be no change in flooding, sediment, or erosion when compared to baseline conditions in the extended plan area for the Stanislaus and Tuolumne Rivers. Flood control releases from the upstream reservoirs on the Stanislaus and Tuolumne Rivers would not increase and peak flows would be similar to baseline because storage in the upstream reservoirs would generally remain the same or be lower than under baseline. Additionally, bypass flows would not be required if they would result in flood control releases from the rim reservoirs. Consequently, there would be no impacts on flooding, sediment, or erosion compared to baseline conditions due to an inability to store water.

The nature of the river channels (predominantly contained in bedrock with very coarse-grained sediment) in the extended plan area means there would be minimal potential for increased sediment transport, erosion, or flooding under LSJR Alternatives 2, 3, or 4 with or without adaptive implementation on the Stanislaus, Tuolumne, and Merced Rivers. Additionally, peak flows would be no higher than under baseline. While higher flows, particularly under LSJR Alternatives 3 and 4 with or without adaptive implementation, might cause more frequent inundation of shallow point bars and occasional low elevation areas along the river channels, this would not be significant because such inundation occurs under baseline conditions and the inundation would not cause channel changes. Consequently, impacts associated with flooding, sediment, and erosion would be less than significant in the extended plan area under LSJR Alternatives 2, 3, and 4 with or without adaptive implementation.

6.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 7
Aquatic Biological Resources

7.1 Introduction

This chapter describes the environmental setting for aquatic biological resources and the regulatory background associated with this resource area. It also evaluates environmental impacts on aquatic biological resources that could result from the Lower San Joaquin River (LSJR) alternatives, the significance of any impacts, and, if applicable, the mitigation measures that would reduce significant impacts.

The Southern Delta Water Quality (SDWQ) alternatives would not affect aquatic biological resources. As summarized in Section 7.4.2, *Methods and Approach*, the SDWQ alternatives would not result in a change in the water quality at Vernalis and, therefore, would not result in a change from baseline conditions. As discussed in Chapter 5, *Surface Hydrology and Water Quality,* and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta,* it is not expected that salinity within the southern Delta would exceed historical monthly salinity levels, which generally range between 0.2 deciSiemens per meter (dS/m) (0.134 parts per thousand [ppt]) and 1.2 dS/m, (0.768 ppt), which are levels that indicator species can tolerate. Therefore, the SDWQ alternatives are not analyzed in detail in this chapter.

As described in Chapter 1, *Introduction*, the plan area generally includes those portions of the San Joaquin River (SJR) Basin that drain to, divert water from, or otherwise obtain beneficial use (e.g., surface water supplies) from the three eastside tributaries[1] of the LSJR. These include the Stanislaus River from and including New Melones Dam and Reservoir to its confluence with the LSJR; the Tuolumne River from and including New Don Pedro Dam and Reservoir to its confluence with the LSJR; the Merced River from and including New Exchequer Dam and Lake McClure to its confluence with the LSJR; and, the SJR between its confluence with the Merced River and downstream to Vernalis (i.e., LSJR). The evaluation of impacts in this chapter focuses on these water resources within the plan area that comprise the ecosystem for aquatic species. This chapter also evaluates other areas outside of the LSJR and the three eastside tributaries (i.e., the greater San Francisco Bay/Sacramento-San Joaquin Delta [Bay-Delta]), to the extent that environmental impacts from the LSJR and SDWQ alternatives may affect aquatic resources in these areas.

The extended plan area, also described in Chapter 1, *Introduction,* generally includes the area upstream of the rim dams[2]. The area of potential effects for this area is similar to that of the plan area and includes the zone of fluctuation around the numerous reservoirs that store water on the Stanislaus and Tuolumne Rivers. (The Merced River does not have substantial upstream reservoirs that would be affected.) It also includes the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

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[1] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[2] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

This chapter evaluates the potential for impacts on aquatic resources as a result of the LSJR and SDWQ alternatives within the plan area. Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30,* evaluates the various benefits for native fishes potentially resulting from the LSJR alternatives. Chapter 19 focuses on the benefits of temperature and floodplain inundation to Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*) as a result of the LSJR alternatives (including the adaptive implementation approaches describe in the program of implementation). Chapter 19 quantitatively evaluates temperature and floodplain inundation during February–June and compares conditions between baseline and the various LSJR alternatives on the three eastside tributaries and the LSJR.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Board determined whether the plan amendments[3] would cause any adverse impact on resources in each of the listed environmental categories and provided a brief explanation for its determination. Impacts in the checklist that are identified as "Potentially Significant Impacts" are discussed in detail in the resource chapters.

This chapter addresses Appendix B, Section IV, *Biological Resources*, and the potential for the plan amendments to have a substantial adverse impact on sensitive or special status aquatic species, either directly or through habitat modification, including interference with migratory movement or reproductive sites. Potential impacts on terrestrial species are analyzed in Chapter 8, *Terrestrial Biological Resources.* Due to the complexity of aquatic resources, review in this chapter is accomplished through analyzing specific potential impacts, described as Impacts AQUA-1 through AQUA-12 (Table 7-1). Accordingly, this chapter evaluates potential impacts in greater detail than those directly specified in Appendix B so as to thoroughly analyze the project on aquatic resources.

The LSJR alternatives could affect reservoir operations in the Stanislaus, Tuolumne, and Merced Rivers, flows in each of these tributaries, and flows in the LSJR and Delta, resulting in potential impacts on aquatic habitat and aquatic biological communities, including native and nonnative fish species. The following analysis evaluates the impacts on aquatic resources that are expected to result from the LSJR alternatives based on the predicted responses of indicator species to the frequency and magnitude of flows, water temperature, and other habitat metrics relative to baseline conditions.

The potential impacts of the LSJR alternatives on aquatic resources are summarized in Table 7-1 as Impacts AQUA-1 through AQUA-12. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 each includes four methods of adaptive implementation. The recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative, is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 7-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR/SDWQ Alternative 1), are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR*

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[3] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

Alternative 1 and SDWQ Alternative 1). Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to actions and methods of compliance.

The indicator species, or key evaluation species, used to determine impacts of the LSJR alternatives on aquatic resources include anadromous[4] fish (fall-run Chinook salmon and steelhead), coldwater reservoir fish (e.g., rainbow trout[5]), and warmwater reservoir fish (e.g., largemouth bass). Indicator species were selected based on their sensitivity to expected changes in environmental conditions in the plan area and their utility in evaluating broader ecosystem and community-level responses to environmental change. In particular, the responses of Central Valley fall-run Chinook salmon to changes in flow, water temperature, and other flow-related variables have been well studied and provide a general indication of the overall response of the ecosystem to hydrologic change.

Table 7-1. Summary of Aquatic Resources Impact Determinations

Alternative	Summary of Impact (s)	Impact Determination with or without Adaptive Implementation
Impact AQUA-1: Changes in spawning success and habitat availability for warmwater species resulting from changes in reservoir water levels		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Significant[c]
LSJR Alternatives 2, 3, and 4	The frequency of 15-foot fluctuations in reservoir levels would not change or would be reduced relative to baseline conditions; therefore, no significant reductions in spawning success and habitat availability for warmwater species would occur.	Less than significant
Impact AQUA-2: Changes in availability of coldwater species reservoir habitat resulting from changes in reservoir storage		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Significant[c]
LSJR Alternatives 2, 3, and 4	Changes in average reservoir storage levels at the end-of-September would range from little or no change to substantial increases relative to baseline levels; therefore, no significant reductions in coldwater habitat availability would occur.	Less than significant
Impact AQUA-3: Changes in quantity/quality of physical habitat for spawning and rearing resulting from changes in flow		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Less than significant[c]
LSJR Alternative 2	Suitable spawning habitat on the three eastside	Less than significant

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[4] *Anadromous* refers to fish that are born in freshwater then migrate to the ocean for feeding and growth, finally returning to freshwater to spawn.

[5] Rainbow trout and steelhead are the same species, *Oncorhynchus mykiss*, but distinguished taxonomically by their different forms. In this document *rainbow trout* refers to the form of this species that remains mostly or entirely in freshwater while *steelhead* refers to the anadromous form. It should be recognized that both forms exist in populations with access to the ocean, including populations within the plan area.

Alternative	Summary of Impact (s)	Impact Determination with or without Adaptive Implementation
	tributaries would remain unchanged or increase. Therefore, no significant adverse impacts on the amount of spawning habitat for Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers would occur. No reductions in Chinook salmon fry and juvenile rearing habitat are expected on the Stanislaus River or LSJR compared to baseline. In the Tuolumne and Merced Rivers, weighted usable area (WUA) for Chinook salmon fry and juvenile rearing would decrease, but floodplain habitat would increase in response to higher spring flows. No substantial differences would occur in WUA for steelhead fry and juvenile rearing compared to baseline conditions. No long-term reductions in habitat availability for other native fish species would occur. Therefore, no significant adverse impacts on the amount of habitat for Chinook salmon, steelhead, and other native fishes in the Stanislaus, Tuolumne and Merced Rivers and the LSJR would occur.	
LSJR Alternative 3	Reductions in WUA for Chinook salmon spawning would occur in the three eastside tributaries, but higher flows and lower temperatures are expected to improve attraction and migration and the longitudinal extent of suitable spawning habitat. SJR Alternative 3 would substantially improve rearing habitat conditions for Chinook salmon and steelhead in the three eastside streams and LSJR. Considering the overall beneficial effects of higher flows on rearing habitat availability, no significant adverse impacts on Chinook salmon and steelhead populations would occur. Higher spring flows under LSJR Alternative 3 would also benefit other native fish species.	Less than significant
LSJR Alternative 4	Under LSJR Alternative 4, predicted changes in WUA values for Chinook salmon and steelhead spawning in the Stanislaus, Tuolumne, and Merced Rivers would be similar in magnitude to those predicted under LSJR Alternative 3. LSJR Alternative 4 would further improve rearing habitat conditions for Chinook salmon and steelhead in the three eastside tributaries and LSJR. Higher spring flows under LSJR Alternative 4 would also further improve habitat conditions for other native fish species. Therefore, no significant adverse impacts would occur.	Less than significant

Alternative	Summary of Impact (s)	Impact Determination with or without Adaptive Implementation
Impact AQUA-4: Changes in exposure of fish to suboptimal water temperatures resulting from changes in reservoir storage and releases		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[a]	Significant[c]
LSJR Alternative 2	No substantial changes would occur in exposure of Chinook salmon and steelhead adult migration, spawning and incubation, juvenile rearing, and smolt life stages to suboptimal water temperatures in the Stanislaus, Tuolumne, Merced, and LSJR. Therefore, no significant adverse impacts on Chinook salmon and steelhead populations would occur.	Less than significant
LSJR Alternative 3	Decreases in exposure of Chinook salmon and steelhead life stages to suboptimal water temperatures would occur for spawning/incubation in the Tuolumne River (March); spring rearing in the Tuolumne, Merced, and LSJR (April–May); and summer rearing (steelhead only) in the Stanislaus, Tuolumne, and Merced Rivers (July). Therefore, no significant adverse impacts would occur. LSJR Alternative 3 would have beneficial temperature effects on Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers (including Chinook salmon reared at Merced River Hatchery), and the LSJR.	Less than significant
LSJR Alternative 4	Decreases in exposure of Chinook salmon and steelhead life stages to suboptimal water temperatures would occur for spawning/incubation in the Stanislaus, Tuolumne, and Merced Rivers (February–March); spring rearing in the Stanislaus, Tuolumne, Merced, and LSJR (March–May); spring outmigration in the Stanislaus, Tuolumne, and Merced Rivers (April–June); and summer rearing (steelhead only) in the Tuolumne River (July). Therefore, no significant adverse impacts would occur. Overall, LSJR Alternative 4 would have beneficial temperature effects on Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers (including Chinook salmon reared at Merced River Hatchery), and the LSJR.	Less than significant

Alternative	Summary of Impact (s)	Impact Determination with or without Adaptive Implementation
Impact AQUA-5: Changes in exposure to pollutants resulting from changes in flow		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Significant[c]
LSJR Alternative 2	Changes in the frequency and magnitude of flows would not be sufficient to result in long-term adverse changes in dilution effects and exposure of fish to potentially harmful contaminants.	Less than significant
LSJR Alternative 3	Similar or higher 10th and 50th (median) percentile flows in most months would result in similar or reduced long-term exposure of fish to potentially harmful pollutants. Decreases in exposure of Chinook salmon and steelhead life stages to suboptimal water temperatures would contribute to reductions in the potential for adverse effects associated with contaminant exposure.	Less than significant
LSJR Alternative 4	Dilution would potentially increase as a result of the increase in flows, and temperatures would either be maintained or reduced; thus, an increase in exposure to pollutants would not occur.	Less than significant
Impact AQUA-6: Changes in exposure to suspended sediment and turbidity resulting from changes in flow		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Less than significant[c]
LSJR Alternatives 2, 3, and 4	Changes in the frequency, duration, and magnitude of increased suspended sediment and turbidity levels would be minor and within the range of historical levels experienced by native fishes and other aquatic species on the three eastside tributaries and the LSJR.	Less than significant
Impact AQUA-7: Changes in redd dewatering resulting from flow fluctuations		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Less than significant[c]
LSJR Alternatives 2, 3, and 4	There would be no substantial changes on the three eastside tributaries or the LSJR in the frequency and magnitude of flow reductions associated with potential impacts on Chinook salmon and steelhead redd dewatering.	Less than significant
Impact AQUA-8: Changes in spawning and rearing habitat quality resulting from changes in peak flows		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Less than significant[c]
LSJR Alternatives 2, 3, and 4	Modeled results indicate that changes in peak flows are not expected to affect the frequency and magnitude of gravel mobilization events in the Stanislaus, Tuolumne, and Merced Rivers. Therefore, no long-term changes in geomorphic conditions	Less than significant

Alternative	Summary of Impact (s)	Impact Determination with or without Adaptive Implementation
	significantly affecting spawning and rearing habitat quality would occur.	
Impact AQUA-9: Changes in food availability resulting from changes in flow and floodplain inundation		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Less than significant[c]
LSJR Alternative 2	No substantial changes are likely to occur in frequency and magnitude of floodplain inundation and associated food web conditions in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Therefore, no significant impacts on food availability would occur.	Less than significant
LSJR Alternatives 3 and 4	Higher spring flows and associated increases in riparian and floodplain inundation in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would potentially increase food abundance and growth opportunities for fish on floodplains as well as contribute to downstream food web support. This represents a beneficial effect on aquatic biological resources in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.	Less than significant
Impact AQUA-10: Changes in predation risk resulting from changes in flow and water temperature		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Significant[c]
LSJR Alternative 2	No substantial changes are predicted to occur in habitat availability and water temperatures potentially affecting Chinook salmon and steelhead populations or conditions supporting predator populations.	Less than significant
LSJR Alternatives 3 and 4	Higher flows and cooler water temperatures in the three eastside tributaries would reduce predation impacts by improving growth opportunities and reducing temperature-related stress in juvenile Chinook salmon and steelhead and limiting the distribution and abundance of largemouth bass and other nonnative species that prey on juvenile salmonids.	Less than significant
Impact AQUA-11: Changes in disease risk resulting from changes in water temperature		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [a]	Significant[c]
LSJR Alternatives 2, 3, and 4	The frequency of spring water temperatures associated with potential increases in disease risk would stay the same or decrease.	Less than significant

Alternative	Summary of Impact (s)	Impact Determination with or without Adaptive Implementation
Impact AQUA-12: Changes in southern Delta and estuarine habitat resulting from changes in SJR inflows and export effects		
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[a]	Less than significant[c]
LSJR Alternatives 2, 3, and 4	No substantial changes in southern Delta and estuarine habitat would occur. The combination of monthly changes in pumping rates, SJR flow, and Delta outflow would not have substantial long-term effects on flow patterns in the southern Delta. Furthermore, there would be little effect on Delta outflows and the position of X2;[b] Delta operations would continue to be governed by current restrictions on export pumping rates, inflow/export ratios, and Old Middle River flows to protect listed fish species from direct and indirect impacts of southern Delta operations.	Less than significant

[a] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives established in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* the No Project Alternative impact discussion, and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

[b] X2 is the location of the 2 parts per thousand (ppt) salinity contour (isohaline), 1 meter off the bottom of the estuary measured in kilometers upstream from the Golden Gate Bridge. The abundance of several estuarine species has been correlated with X2. In the 2006 Bay-Delta Plan, a salinity value—or electrical conductivity (EC) value—of 2.64 millimhos/centimeter (mmhos/cm) is used to represent the X2 location. Note, in this SED, EC is generally expressed in deciSiemens per meter (dS/m). The conversion is 1 mmhos/cm = 1 dS/cm.

[c] Adaptive implementation does not apply to the No Project Alternative.

7.2 Environmental Setting

This section describes the life history, habitat requirements, and factors that affect the abundance of aquatic biological resources, including special-status, recreational, and indicator species in the plan area, and reviews historical and current fish communities and environmental stressors in the LSJR, three eastside tributaries, and the southern Delta. Additional background information and technical support for Section 7.2, *Environmental Setting*, and Section 7.4, *Impact Analysis*, are presented in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*. In particular, Appendix C, Chapter 3, *Scientific Basis for Developing Alternative San Joaquin River Flow Objectives*, provides additional information on the life history of the indicator species (Chinook salmon and steelhead), detailed descriptions of existing fish monitoring and research programs, and reviews of published and unpublished technical information supporting current scientific understanding of the roles of flow, water temperature, and other mechanisms affecting Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.

7.2.1 Fish Species

The LSJR, the three eastside tributaries, and the southern Delta support a diverse assemblage of native and nonnative fishes. Historically, the SJR and the three eastside tributaries in the plan area supported a distinctive native fish fauna adapted to widely fluctuating riverine conditions ranging from large winter and spring floods to low summer flows. Prior to large-scale hydrologic and physical alteration of the basin and species introductions, these environmental conditions resulted in a rich and diverse native fish fauna characterized by four major fish assemblages. The rainbow trout assemblage occurred in high gradient, upper elevation portions of the SJR basin, and commonly included riffle sculpin (*Cottus gulosus*), Sacramento sucker (*Catostomus occidentalis*), and speckled dace (*Rhinichthys osculus*). The California roach assemblage occurred in small, warm tributaries at middle elevations, and may have seasonally included Sacramento sucker, Sacramento pikeminnow, Chinook salmon, and steelhead. The Pikeminnow-hardhead-sucker assemblage historically occurred in larger mainstem portions of the SJR and its tributaries and included speckled dace, California roach, riffle and prickly sculpin, threespine stickleback, and rainbow trout. Anadromous species, including Chinook salmon, steelhead (anadromous or sea-run rainbow trout), and Pacific lamprey, spawned and reared in this zone. The deep-bodied fish assemblage generally occurred in the low gradient, valley-bottom portions of the SJR, and included Sacramento perch (*Archoplites interruptus*), thicktail chub, tule perch, hitch, and blackfish. Chinook salmon, steelhead, and sturgeon occurred in this zone on their way upstream to spawn or on their way downstream toward the ocean (Moyle 2002).

The fish assemblages that currently occur in SJR and the three eastside tributaries are the result of substantial changes to the physical environment and a long history of species introductions. A number of the native species are now uncommon, rare, or extinct, and have been designated as special-status species (Table 7-2). Some of these special-status species (e.g., rainbow trout, fall-run Chinook salmon, and steelhead) are the indicator species mentioned in Section 7.1, *Introduction*. Other species, both native and nonnative, support important recreational fisheries in the plan area (Table 7-3).

Table 7-2. Special-Status Fish Species that Occur in the Plan Area

	Status[a]	Recreationally Important?			Critical Habitat Designated?
Species Name	Fed/State	Yes/No	Location	Habitat	
Central Valley fall-/late fall–run Chinook salmon[b] *Oncorhynchus tshawytscha*	SC/–	Yes	Pacific Ocean, San Francisco Bay-Sacramento-San Joaquin Delta (Bay-Delta), SJR and the three eastside tributaries, Sacramento River and major tributaries.	Prefer well-oxygenated, cool, riverine habitat with water temperatures 8.0°C–12.5°C (46.5°F–54.5°F). Habitat types are riffles, runs, and pools.	No

	Status[a]	Recreationally Important?			
Species Name	Fed/State	Yes/No	Location	Habitat	Critical Habitat Designated?
Central Valley spring-run Chinook salmon *Oncorhynchus tshawytscha*	T/CT	No	Pacific Ocean, Bay-Delta, Sacramento River and major tributaries.	Prefer well-oxygenated, cool, riverine habitat with water temperatures 8.0°C–12.5°C (46.5°F–54.5°F). Coldwater pools are needed for holding adults.	Yes, but not in the plan area.
Central Valley steelhead[b] *Oncorhynchus mykiss*	T/–	Yes	Pacific Ocean, Bay-Delta, SJR and three eastside tributaries, Sacramento River and major tributaries.	Prefer well-oxygenated, cool, riverine habitat with water temperatures 7.8°°C–18°C (46°F–64.4°F). (Moyle 2002). Habitat types are riffles, runs, and pools.	Yes, the LSJR from the Merced River confluence to Vernalis, including the three eastside tributaries, and the southern Delta.
Green sturgeon (southern DPS) *Acipenser medirostris*	T/CSC	No	Pacific Ocean, Bay-Delta, Sacramento River.	Occur in both freshwater and saltwater habitat. Spawn in deep pools or in turbulent areas in the mainstem of large rivers (Moyle 2002) with well-oxygenated water with temperatures 8°C–14°C (46.5°F–57.2°F). Salinity tolerance to 35 ppt for adults.	Yes, the Bay-Delta.
Delta smelt *Hypomesus transpacificus*	T/CE	No	Primarily in the Bay-Delta, but has been found as far upstream as the mouth of the American River, on the Sacramento River, and at Mossdale on the SJR; range extends downstream to San Pablo Bay.	Endemic to the Bay-Delta and generally spend entire lifecycle in the open surface waters of the Bay-Delta and Suisun Bay. Prefer areas where fresh and brackish water mix in the salinity range of 2–7 ppt. Salinity tolerance to 19 ppt, sometimes higher (Bennett 2005).	Yes, the legal Delta and Suisun Bay and Marsh.

Species Name	Status[a] Fed/State	Recreationally Important? Yes/No	Location	Habitat	Critical Habitat Designated?
Longfin smelt *Spirinchus thaleichthys*	–/CT	No	Primarily in the Bay-Delta, but also in Humboldt Bay, Eel River estuary, and Klamath River estuary.	Primary habitat is the open water of estuaries; can be found in both the seawater and freshwater areas, typically in the middle or deeper parts of the water column. Salinity tolerance to 35 ppt. Spawning takes place in salt or brackish estuary waters with freshwater inputs (Merz et al. 2013).	No
Sacramento splittail *Pogonichthys macrolepidotus*	–/CSC	No	Throughout the year in low-salinity waters and freshwater areas of the Bay-Delta, Yolo Bypass, Suisun Marsh, Napa River, and Petaluma River (Moyle 2002).	Utilize floodplain habitat for feeding and spawning. Spawn among submerged and flooded vegetation in sloughs and the lower reaches of rivers. Estuarine species found 10–18 ppt, can tolerate up to 29 ppt (Cech et al. 1990).	No
Kern brook lamprey *Lampetra hubbsi*	–/CSC	No	Lower Merced River, Kaweah River, Kings River, and SJR.	Silty and backwaters and stream margins of Sierra foothill rivers.	No
River lamprey *Lampetra ayresi*	–/CSC	No	Bay-Delta and SJR from Friant Dam to Merced River and the LSJR.	Has not been thoroughly studied in California but appears to be more abundant in the Lower Sacramento River and LSJR than in other streams in California.	No

	Status[a]	Recreationally Important?			
Species Name	Fed/State	Yes/No	Location	Habitat	Critical Habitat Designated?
California roach (Sacramento-San Joaquin roach and Red Hills roach) *Lavinia symmetricus ssp.*	–/CSC	No	Sacramento–San Joaquin Watersheds; Red Hills roach known to occur only in several small streams in Tuolumne River basin.	California roach generally occur in small, warm streams, and individuals frequent a wide variety of habitats, often isolated by downstream barriers. Tolerant of relatively high water temperatures 30°C–35°C (86°F–95°F) with low oxygen levels.	No
Pacific lamprey *Entosphenus tridentatus*	SC/–	No	Pacific Ocean, Bay-Delta, SJR and three eastside tributaries, Sacramento River.	Prefer well-oxygenated, cool, riverine habitat with water temperatures 12°C–18°C (53.5°F–64.5°F). Spawning habitats are similar to that of salmonids. They are anadromous.	No
Hardhead *Mylopharodon conocephalus*	–/CSC	No	SJR and the three eastside tributaries, Sacramento River and major tributaries.	Prefer low to mid-elevation environments with clear, deep pools and runs with sand-gravel-boulder substrates. Optimal water temperatures range from 24°C–28°C (75°F–82°F); however, most streams where these fish occur have temperatures over 20°C (68°F) (Moyle 2002).	No

	Status[a]	Recreationally Important?			
Species Name	Fed/State	Yes/No	Location	Habitat	Critical Habitat Designated?

DPS = Distinct population segment
°F = Degrees Fahrenheit
°C = Degrees Celsius
ppt = Parts per thousand

[a] Status:

Federal

E = Listed as endangered under the federal Endangered Species Act (ESA).
T = Listed as threatened under ESA.
SC = Listed as a species of concern.
– = No federal status.

State

CE = Listed as endangered under the California Endangered Species Act (CESA).
CT = Listed as threatened under CESA.
CSC = California species of special concern.
– = No state status.

[b] Central Valley fall-run Chinook salmon and Central Valley steelhead are considered indicator species of coldwater communities.

Table 7-3. Recreationally Important Fish Species in the Plan Area

	Status	Recreationally Important?			
Species Name	Fed/State	Yes/No	Location	Habitat	Critical Habitat Designated?
Rainbow trout *Oncorhynchus mykiss*[a, b]	–/–	Yes	SJR and the three eastside tributaries, Sacramento River and major tributaries. Also stocked in reservoirs in the plan area.	Prefer well-oxygenated, cool, riverine habitat with water temperatures 7.8°C–18°C (46°F–64.4°F). Habitat types are riffles, runs, and pools.	No
Largemouth bass[b] *Micropterus salmoides*	–/–	Yes	Bay-Delta, SJR, Sacramento River, and tributaries. Also stocked in reservoirs in the plan area.	Found in warm, quiet water with low turbidity and aquatic plants, such as lakes, reservoirs, sloughs, and river backwaters. Constructs its nests for eggs in shallow water. Optimal temperatures range from 25°C–30°C (77°F–86°F) but can persist in temperatures that approach 36°C–37°C (97°F–99°F) (Moyle 2002).	Not applicable – nonnative introduced species

Species Name	Status Fed/State	Recreationally Important? Yes/No	Location	Habitat	Critical Habitat Designated?
Striped bass *Morone saxatilis*	–/–	Yes	Bay-Delta, SJR and three eastside tributaries, Sacramento River and major tributaries.	Found in lakes, ponds, streams, wetlands, and brackish and marine waters. Anadromous, they spawn in fresh water in the spring (April–May) when water temperatures are about 15.5°C (60°F).	Not applicable - nonnative introduced species
White sturgeon *Acipenser transmontanus*	–/–	Yes	Pacific Ocean, Bay-Delta.	Inhabits riverine, estuarine, and marine (35 ppt) habitats at various life stages (Moyle 2002). Greatest portion of the population occurs in the brackish portion of the estuary.	No
American shad *Alosa sapidissima*	–/–	Yes	Bay-Delta, Sacramento River, and SJR. Also stocked in reservoirs in the plan area.	Prefer well-oxygenated, cool, riverine habitat. Peak spawning occurs in mid-May to mid-June, with water temperatures of 11°C–17°C (51.8°F–62.6°F).	Not applicable – nonnative introduced species
Kokanee *Oncorhynchus nerka*	–/–	Yes	Reservoirs in the plan area.	Landlocked populations occur in well-oxygenated reservoirs on three eastside tributaries. Preferred water temperatures are 1°C–15°C (50°F–59°F).	Not applicable – nonnative introduced species

°F = degrees Fahrenheit

°C = degrees Celsius

[a] In this document, *rainbow trout* refers to non-anadromous forms of the species *O. mykiss* above impassable dams. However, it should be recognized that both anadromous (steelhead) and non-anadromous forms occur below these dams. The anadromous form is recognized by the National Marine Fisheries Service as a distinct population segment of *O. mykiss*, which is listed as threatened under the ESA (see Table 7-2).

[b] Largemouth bass are considered an indicator species of warmwater reservoir fish communities that include fishes such as sunfish and catfish. Rainbow trout are considered an indicator species of coldwater reservoir fish communities.

Chinook Salmon

Central Valley Fall-Run

The Central Valley fall-run Chinook salmon evolutionarily significant unit (ESU) is listed as a federal species of concern. Currently, fall-run Chinook salmon are the most abundant of the Central Valley races, contributing historically to large commercial and recreational fisheries in the ocean and popular sport fisheries in the freshwater streams. Fall-run Chinook are raised at five major Central Valley hatcheries that release more than 32 million smolts each year (CDFW 2016a). The federal status of fall-run Chinook salmon is due in part to concerns regarding hatchery influence.

Central Valley fall-run Chinook salmon historically spawned in all major Central Valley tributaries, as well as the mainstem of the Sacramento River and SJR (Moyle 2002). Because much of fall-run Chinook salmon historical spawning and rearing habitat included the reaches downstream of major dams, the fall runs in the Central Valley were not as severely affected by early water projects as were spring-run Chinook salmon and steelhead, which ascended to higher elevations to spawn (Reynolds et al. 1993; Yoshiyama et al. 1996; McEwan 2001). Changes in seasonal hydrologic patterns resulting from operation of upstream reservoirs for water supplies, flood control, and hydroelectric power generation have altered instream flows and habitat conditions for fall-run Chinook salmon and other species downstream of the dams (Williams 2006).

Trends in adult fall-run Chinook salmon escapement on the SJR and the three eastside tributaries have been relatively low since the 1950s, ranging from several hundred adults to approximately 100,000 adults. Results of escapement estimates have shown a relationship between adult escapement in one year and spring flows on the SJR 2.5 years earlier when the juveniles in the cohort were rearing and migrating downstream through the Sacramento-San Joaquin Delta (Delta). Adult escapement appears to be cyclical and may be related to hydrology during juvenile rearing and migration periods, among other factors (CDFG 2005; SJRTC 2008). Population trends for fall-run Chinook salmon are discussed in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*.

SJR fall-run Chinook salmon migrate into natal streams from late October to early December, with peak migration typically occurring in November (Table 3.13 of Appendix C). SJR fall-run Chinook salmon typically begin spawning between November and January when temperatures in the rivers are lower than 55°F. The majority of redds (a gravel depression in the riverbed the adults make with their tails for spawning) are observed in the month of November (McBain and Trush 2002). Egg incubation typically occurs between November and March, lasting 40–60 days, but can vary depending on water temperatures and timing of spawning. Optimal water temperatures for egg incubation range from 41 degrees Fahrenheit (°F) to 55°F (Moyle 2002; USEPA 2003). Eggs that incubate at temperatures higher than 60°F and lower than 38°F have suffered high mortality rates (Boles et al. 1988).

Newly hatched salmon (alevins) remain in the gravel for about 4–6 weeks, depending on surrounding water temperatures, until the yolk sac has been absorbed (Moyle 2002; NMFS 2009a). Generally, alevins suffer low mortality when consistently incubated at water temperatures between 50°F and 55°F. However, if incubated at constant temperatures between 55°F and 57.5°F, mortality has been shown to increase in excess of 50 percent (Boles et al. 1988).

Most fall-run Chinook salmon fry (the life stage after alevins) emerge from the gravel between February and March (McBain and Trush 2002) and are immediately dispersed into downstream feeding areas. However, many juveniles may rear in the river for some length of time before migrating downstream (Moyle 2002). Rearing and outmigration of fall-run Chinook salmon typically occurs between February and June; however, rotary screw trap and trawl data from the LSJR and its tributaries indicate that peaks in fry outmigration occur in February and March, and peaks in smolt (> 75 mm) outmigration occur in April and May.

Preferred rearing temperatures for Chinook have been reported to occur within the range of 54°F–58.5°F (12.2°C–14.7°C) (Hicks 2002) with optimum temperatures for growth occurring at temperatures of 50°F–60°F (10°C–15.6°C) (McCullough et al. 2001). Chinook salmon exhibit positive growth at temperatures ranging from 46.4°F–77°F (8°C–25°C), with optimum growth rates occurring at about 66.2°F (19°C) when fed maximal rations (Myrick and Cech 2001).

Juvenile Central Valley fall-run Chinook salmon undergo a change known as *smoltification* when they reach 3–4 inches (75–100 millimeters [mm]) during outmigration. Smoltification involves physiological and morphological changes that prepare juveniles for ocean entry (CDFG 2010). Elevated stream temperatures during rearing or downstream smolt migration can inhibit smolt development in anadromous salmonids. Water temperatures that have been reported in the literature to impair smoltification range from approximately 53.6°F–59°F (12°C–15°C) (McCullough et al. 2001). Evidence of impaired smoltification in Central Valley fall-run Chinook salmon has been observed at water temperatures above approximately 60.8°F (16°C), with significant impairment occurring at water temperatures above approximately 68°F (20°C) (Marine and Cech 2004).

Central Valley Spring-Run

The Central Valley spring-run ESU is a special-status species currently listed as threatened under the Endangered Species Act (ESA) and the California Endangered Species Act (CESA).

Spring-run Chinook salmon once occupied all major river systems in California and were widely distributed in Central Valley rivers (Myers et al. 1998). Spring-run Chinook salmon were widely distributed in streams of the Sacramento River and SJR Basins, spawning and rearing over extensive areas in the upper and middle reaches (elevations ranging from 1,400 to 5,200 feet (ft) [450 to 1,600 meters (m)]) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit Rivers (Myers et al. 1998). Run sizes in the nineteenth century were probably in the range of 1 million fish per year +/-500,000 (Yoshiyama et al. 1998; Moyle et al. 2008). From 1900 to 1948, hydroelectric development and irrigation projects truncated large portions of the headwaters of most Central Valley Rivers by dam construction and greatly reduced access of spring-run Chinook salmon to spawning habitat (Yoshiyama et al. 1996). The SJR population was essentially extirpated by the late 1940s. Populations in the Upper Sacramento, Feather, and Yuba Rivers were eliminated with the construction of major dams during the 1950s and 1960s. Naturally spawning populations of spring-run Chinook salmon are currently restricted to accessible reaches of the Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Mill Creek, Feather River, and Yuba River (CDFG 1998). Naturally-spawning populations of Central Valley spring-run Chinook salmon with consistent spawning returns use the Bay-Delta as a migration corridor and are currently restricted to Butte Creek, Deer Creek, and Mill Creek (Moyle 2002; Good et al. 2005).

Currently, no spring-run Chinook salmon populations are found in the tributaries of the SJR (NMFS 2014), although there are occasional observations of small numbers of Chinook salmon in the tributaries that display spring-run characteristics. It is not well understood if these fish are in fact spring-run Chinook salmon, and if they are, from which Sacramento River tributary they have strayed from. Spring-run Chinook salmon populations were extirpated from the SJR Basin after construction of Friant Dam, which was completed in 1948 (Moyle 2002). However, in 2006 parties agreed to a stipulated settlement that required the reintroduction of spring-run Chinook salmon to this section of the SJR and required minimum flows to sustain the reintroduced population. In 2009, through the San Joaquin River Restoration Program (SJRRP),[6] the first restoration flows were released from Friant Dam. In 2010, the SJR reconnected to the LSJR at the Merced River confluence. The major goal of the SJRRP is to establish a naturally self-sustaining population (see Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*, for a discussion of the program) (USBR 2011).

The Central Valley spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance between 1960 and 2009. Although recent population trends are negative, annual abundance estimates display a high level of variation. The overall number of spring-run Chinook salmon remains well below estimates of historical abundance. Central Valley spring-run Chinook salmon have some of the highest population growth rates in the Central Valley, but other than in Butte Creek and the hatchery-influenced Feather River, population sizes are very small relative to fall-run Chinook salmon populations (Good et al. 2005).

In general, physical parameters (e.g., temperature and salinity thresholds) for spring-run Chinook salmon are similar to that of fall-run Chinook salmon, although the timing of the freshwater lifecycle is different. Spring-run Chinook salmon enter freshwater in the winter and spring and spawn in the late summer. This life history requires that they migrate far enough upstream to find habitat that remains cool enough (less than 70°F) for the adults to survive (Williams 2006). Embryos are less tolerant of warm water than adults, and as with fall-run Chinook salmon, spawning begins when water cools below 57°F to 59°F. The spring-run Chinook salmon lifecycle is well adapted to streams with snowmelt runoff and access to high elevation holding and spawning habitat (Williams 2006).

Rainbow Trout and Central Valley Steelhead

Rainbow trout and steelhead are the same species, *O. mykiss*, but distinguished by their behavior. All forms of the species spend the first part of their lives in freshwater, but steelhead are anadromous, migrating to the ocean (35 ppt) after 1–3 years. Rainbow trout are the most abundant and wide-spread native salmonids in western North America and recreationally important species. Hatchery and naturally produced populations of rainbow trout occur in reservoirs, lakes, and streams above impassable dams throughout California, and are sustained by both stocking and natural reproduction. However, mixing of rainbow trout in hatcheries and indiscriminate stocking have blurred distinctions among populations (Moyle 2002). For the purposes of this document, rainbow trout is used to distinguish *O. mykiss* populations above impassable dams, while steelhead is used to distinguish populations below these dams. However, it should be recognized that both forms can occur in *O. mykiss* populations with access to the ocean.

The Central Valley steelhead, a distinct population segment (DPS) of West Coast steelhead, is a special-status species that is listed as threatened under ESA (Moyle 2002), but not under CESA. The general habitat requirements of Central Valley steelhead also apply to rainbow trout as defined here. Historically, Central Valley steelhead were widely distributed throughout the Sacramento River and SJR. Historical Central Valley steelhead run sizes are difficult to estimate given the paucity

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[6] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future.

of data, but may have approached one to two million adults annually (McEwan 2001). Adult steelhead typically migrate upstream and spawn during the winter months when river flows are high and water clarity is low. Unlike Chinook salmon, adult steelhead may not die after spawning and can return to coastal waters. In addition, steelhead frequently inhabit streams and rivers that are difficult to access and survey. Thus, information on the trends in steelhead abundance in the Central Valley has primarily been limited to observations at fish ladders and weirs (McEwan 2001).

Until recently, Central Valley steelhead were thought to be extirpated from the SJR Basin. However, recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras Rivers and other streams previously thought to be devoid of steelhead (McEwan 2001; Zimmerman et al. 2008). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good et al. 2005). Non-hatchery stocks of rainbow trout that have anadromous components within them are found in the Upper Sacramento River and its tributaries: Mill, Deer, and Butte Creeks; and the Feather, Yuba, American, Mokelumne, and Calaveras Rivers (McEwan 2001).

The most recent status review of the Central Valley steelhead DPS (NMFS 2009a) found that the status of the population appears to have worsened since the 2005 status review (Good et al. 2005), when it was considered to be in danger of extinction. Analysis of data from the Chipps Island monitoring program indicates that natural steelhead production has continued to decline, and hatchery-origin fish represent an increasing fraction of the juvenile production in the Central Valley. In recent years, the proportion of hatchery-produced juvenile steelhead in the catch has exceeded 90 percent, and in 2010 it was 95 percent of the catch. This recent trend appears to be related to poor ocean conditions and dry hydrology in the Central Valley (NMFS 2009b). Population trends for Central Valley steelhead are discussed in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*.

Central Valley steelhead in the plan area can begin upstream migration as early as July and continue through April, with upstream migration peaking between October and February. Central Valley steelhead spawn downstream of impassable dams on the three eastside tributaries and the LSJR, similar to SJR Basin fall-run Chinook salmon (NMFS 2009c). Spawning typically occurs from December through June and peaks between January and March (NMFS 2009a; Table 3.14 of Appendix C) where cool (30°F–52°F), well-oxygenated water is available year-round (McEwan and Jackson 1996). Once spawning is complete, adult Central Valley steelhead may return to the ocean in preparation for a subsequent year, while others may die after spawning.

Depending on water temperature, Central Valley steelhead eggs may incubate in redds from 4 weeks to 4 months before hatching as alevins (McEwan 2001; NMFS 2009c). When water temperatures are warmer, less incubation time is needed and, conversely, when water temperatures are cooler, more incubation time is needed. Central Valley steelhead eggs that typically incubate at 50°F–59°F hatch in about 4 weeks, and alevins emerge from the gravel 4–8 weeks after hatching (Shapovalov and Taft 1954; Reynolds et al. 1993). Juvenile Central Valley steelhead rear for 1–3 years (1 percent spend 3 years) in cool, clear, fast flowing, permanent freshwater streams and rivers where riffles predominate over pools (CDFG 2010). Some juveniles may utilize tidal marsh areas, nontidal freshwater marshes, and other shallow water areas in the Bay-Delta as rearing areas for short periods prior to their final emigration to sea (NMFS 2009a).

Juveniles are dependent on suitable rearing habitat for an extended amount of time prior to outmigration, especially during the summer when suitable conditions are most restricted due to a host of stressors such as temperature, water quality and quantity, and ability to access floodplains. Diversity and richness of habitat and food sources, particularly in shallow water habitats, allows juveniles to grow larger before ocean entry, thereby increasing their chances of survival in the marine environment. A longer rearing period for juvenile Central Valley steelhead allows for them to be considerably larger and have a greater swimming ability than Chinook salmon juveniles during outmigration (ICF International 2012).

Central Valley steelhead juveniles generally begin outmigration anywhere between late December and July, with peaks occurring between March and April (McBain and Trush 2002; Table 3.14 of Appendix C; USDOI 2008). As with Chinook salmon, juveniles undergo smoltification during outmigration. Central Valley steelhead smoltification has been reported to occur successfully at 44–52°F (Myrick and Cech 2001; USDOI 2008).

Green Sturgeon

The North American green sturgeon (southern DPS) is a special-status species listed under ESA as threatened and identified as a California species of special concern (Table 7-2).

North American green sturgeon range along the Pacific coast from Mexico to Alaska (Colway and Stevenson 2007; Moyle 2002). Spawning populations of green sturgeon are currently found in three river systems: the Sacramento and Klamath Rivers in California and the Rogue River in southern Oregon (NMFS 2009a). The southern DPS of green sturgeon includes all green sturgeon populations south of the Eel River, with the only known spawning population being in the Sacramento River (NMFS 2009a). Within the Central Valley, green sturgeon have been observed in San Francisco Bay, San Pablo Bay, Suisun Bay, the Delta, Sacramento River, Feather River, Yuba River, Sutter Bypass, and Yolo Bypass (74 FR 52300; Israel and Klimley 2008; Moyle 2002; Gleason et al. 2008; Dubois et al. 2009, 2010, 2011, 2012; NMFS 2005; NMFS 2010). Currently, spawning is limited to the Sacramento River below Shasta and Keswick Dams, which block passage of green sturgeon to historic spawning areas above the dams (NMFS 2005). It is suspected that green sturgeon once spawned in the SJR but have since been extirpated (Moyle 2002; Israel and Klimley 2008). Moyle (2002) suggested that reproduction may have taken place in the SJR because adults have been captured at Santa Clara Shoal and Brannan Island. Egg and larval green sturgeon are confined to freshwater portions of the Sacramento River, while juvenile and sub-adult green sturgeon occur in riverine, subtidal, and intertidal habitats in the Lower Sacramento River and Bay-Delta (Israel and Klimley 2008).

Musick et al. (2000) suggest that the abundance of North American green sturgeon populations has declined as much as 88 percent. Based on the incidental capture of green sturgeon during surveys for white sturgeon, CDFG (2002) estimated that green sturgeon abundance in the Bay-Delta estuary ranged from 175 (1993) to more than 8,400 (2001) adults between 1954 and 2001. However, these estimates are uncertain and subject to the inherent biases of the sampling methods (NMFS 2009a). A decline in abundance is indicated by reductions in the average number of juvenile green sturgeon salvaged at the state and federal pumping facilities in recent years compared with annual salvage estimates before the mid-1980s (NMFS 2009a). A decline in abundance of green and white sturgeon since the 1960s is also evident from a reduction in the number of green and white sturgeon salvaged per acre-foot (AF) of water exported (April 5, 2005, 70 FR 17386). A recent genetic analysis indicated that spawning populations above Red Bluff Diversion Dam ranged from 32 to 124 spawning pairs between 2003 and 2006 (Israel and May 2010).

Green sturgeon pass through the San Francisco Bay to the ocean (35 ppt), where they primarily move northward, spending much of their lives in the ocean or in Oregon and Washington estuaries (Kelley et al. 2007). Adult green sturgeon are marine dependent and spends less time in estuarine and freshwater environments. Typically, these fish spend 3–13 years in the ocean before returning to freshwater to spawn (Moyle 2002). The LSJR and Bay-Delta serve as a migratory corridor, feeding area, and juvenile rearing habitat (ICF International 2012). Adult green sturgeon begin their upstream spawning migration into the San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein et al. 2006). Spawning typically occurs at temperatures between 46°F and 66°F (8°C–19°C) (Moyle 2002). Maximum spawning occurs at 58°F (14.4°C) in the Sacramento River (Kohlhorst 1976). Preferred spawning habitats for green sturgeon are thought to contain large cobble in deep and cool pools with turbulent water (Adams et al. 2002; Moyle 2002).

Larval green sturgeon exhibit nocturnal activity patterns (Cech et al. 2000) and begin nocturnal downstream migrational movements approximately 10 days after hatching (Kynard et al. 2005). Young green sturgeon appear to rear for the first 1 to 2 months in the Upper Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juveniles spend 1–4 years in freshwater and estuarine habitats before they enter the ocean (Nakamoto et al. 1995). Younger fish have a lower salinity tolerance than adults, something that develops at a certain age (Allen et al. 2009).

Delta Smelt

Delta smelt is listed as threatened under ESA and endangered under CESA, and the U.S. Fish and Wildlife Service (USFWS) has designated critical habitat for delta smelt that incorporates the Bay-Delta.

Delta smelt are small fish (55–70 mm), that rarely live more than 1–2 years, have low fecundity, and are not recreationally or commercially fished. Delta smelt is endemic to only the Bay-Delta, and individuals generally spend their entire lifecycles in the open surface waters of the Bay-Delta and Suisun Bay. The geographic distribution of delta smelt includes low salinity and freshwater zones of the Bay-Delta system, including the Sacramento River downstream of Isleton, the Cache Slough subregion (Cache Slough-Liberty Island and the Sacramento Deep Water Ship Channel), the SJR downstream of Mossdale, and Suisun Bay and Suisun Marsh (Moyle 2002). Delta smelt are a euryhaline fish (occurring over a wide range of salinities) that are rarely found in water more than 10–12 ppt salinity; therefore, its distribution is thought to be related largely to freshwater flows into the Bay-Delta (Bennett 2005; Moyle 2002).

Delta smelt typically migrate December–March in response to “first flush” events that increase flow and turbidity in the Delta (Sommer et al. 2011). However, there is evidence of year-round residence of delta smelt in the northwestern Delta (Cache Slough region) (Nobriga et al. 2008; Lehman et al. 2010), possibly because turbidity and prey abundance are sufficient to support them (Sommer et al. 2004; Lehman et al. 2010). Spawning does not begin until late February, with peaks from March–May (Bennett 2005). Embryonic development is reported to last 11–13 days at 57°F–61°F (Moyle 2002). Baskerville-Bridges et al. (2004) reported hatching of delta smelt eggs after 8–10 days at 59°–62.5°F. Although spawning may occur at up to 71.5°F, hatching success of the larvae is very low at that high of temperatures (Bennett 2005). Spawning occurs primarily in sloughs and shallow edge areas in the Sacramento and Mokelumne Rivers and the SJR, the western and southern Delta, Suisun Bay, Suisun Marsh, and occasionally, in wet years, the Napa River (Wang 2007). Delta smelt have been found on the Sacramento River as far upstream as the confluence with American River and as far downstream as Mossdale on the SJR (Moyle 2002; Hobbs et al. 2007).

Upon hatching, larvae are semi-buoyant, staying near the bottom (Bennett et al. 2002), and are transported downstream to the low salinity habitat. However, recent evidence of year-round residence of delta smelt in the areas around Cache Slough indicates that downstream transport is not necessary for successful rearing. Within a few weeks, larvae develop an air bladder and become pelagic (living or occurring in the open sea) (Moyle and Bennett et al. 2002). Young-of-the-year delta smelt (i.e., production from spawning in the current year) rear from late spring through fall and early winter. Once in the rearing stage, growth is rapid, and juvenile fish are commonly 40–50 mm total length (TL) by early August (Radtke 1966). They reach adult size by early fall. Delta smelt growth during the fall months slows considerably (only 3–9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Radtke 1966; Mager 2004). Delta smelt are visual feeders (Baskerville-Bridges et al. 2004), swimming near the water surface and feeding on zooplankton in the wild (USFWS 2008). Feeding is size-based, with first-feeding larvae (5–8 mm standard length [SL]) consuming sub-adult cyclopoid and calanoid copepods (Nobriga 2002) and older larvae (10–15 mm SL) consuming adult copepods (Nobriga 1998).

Delta smelt seem to prefer water with high turbidity, based on a negative correlation between water quality and the frequencies of delta smelt occurrence in survey trawls during summer, fall, and early winter. For example, the likelihood of delta smelt occurrence in trawls at a given sampling station decreases with increasing Secchi depth[7] (Feyrer et al. 2007; Nobriga et al. 2008). This is consistent with behavioral observations of captive delta smelt. Few daylight trawls catch delta smelt at Secchi depths over 0.5 m and capture probabilities are highest at 0.40 m depth or less. Delta smelt's preference for turbid water may be related to increased foraging efficiency and reduced risk of predation (NMFS 2009a).

Temperature and salinity also affect delta smelt distribution. Swanson et al. (2000) indicate delta smelt tolerate temperatures between 46.5°F and 77°F; however, warmer water temperatures of more than 77°F restrict their distribution more than colder water temperatures. Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures are usually less than 77°F in summer (Nobriga et al. 2008). Suisun Bay and Suisun Marsh may be beneficial habitat for delta smelt due to salinity, which ranges from 0.5–10 ppt, though recent evidence suggests their presence may be more due to the food web. Typically, delta smelt follow X2,[8] low salinity habitat <2ppt that has decreased considerably in recent years (Feyrer et al. 2011).

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[7] Secchi depth is a measurement of water clarity. A small white Secchi disk is lowered into the water column until it is no longer visible. Increased Secchi depth is an indicator of clear or less turbid water.

[8] X2 is the location of the 2 parts per thousand salinity contour (isohaline), 1 meter off the bottom of the estuary measured in kilometers upstream from the Golden Gate Bridge. The abundance of several estuarine species has been correlated with X2. In the 2006 Bay-Delta Plan, a salinity value—or electrical conductivity (EC) value—of 2.64 millimhos/centimeter (mmhos/cm) is used to represent the X2 location. Note, in this SED, EC is generally expressed in deciSiemens per meter (dS/m). The conversion is 1 mmhos/cm = 1 dS/cm.

Longfin Smelt

Longfin smelt is a special-status species that is not listed under ESA, but is listed as threatened under CESA (Baxter et al. 2009; California Fish and Game Commission 2009)

Populations of longfin smelt in California historically have been known to occur from the Bay-Delta, Humboldt Bay, the Eel River estuary, and the Klamath River estuary (Emmett et al. 1991). Longfin smelt occur throughout the Bay-Delta, including the Cache Slough region and Yolo Bypass. Adults occur seasonally as far downstream as the South Bay, but they are concentrated in Suisun, San Pablo, and North San Francisco Bays (Baxter 1999). Longfin smelt generally have a 2-year lifecycle. During this second year, they primarily inhabit the San Francisco Bay, but are thought to be pelagic (ocean-going). Thus, they have a salinity tolerance up to 35 ppt, though this is lower in younger life stages.

Spawning typically takes place as early as November and may extend into June, peaking between February and April. Spawning occurs in fresh or slightly brackish water over aquatic vegetation or sandy-gravel substrates when temperatures drop roughly below 64.5°F (Baxter et al. 2009). Based on their distribution patterns during the spawning season, the main spawning area appears to be downstream of Rio Vista on the Sacramento River (ICF International 2012). Spawning probably also occurs in the eastern portion of Suisun Bay and, in some years, the larger sloughs of Suisun Marsh. (Hobbs. et al. 2010). Historically, spawning probably also occurred in the SJR. Recent catches of longfin smelt in the SJR have been extremely low, potentially as a result of low flows in the river, which contribute to habitat degradation, unsuitable water temperature, and poor water quality (Moyle 2002).

Longfin smelt eggs typically hatch in February and disperse downstream (Wang 2007). The principal nursery habitat for larvae is the Suisun and San Pablo Bays (Meng and Matern 2001). However, the distribution of eggs may be shifted upstream in years of low outflow (Moyle 2002). Mortality for longfin smelt is highest February–May when larvae complete fin development (Wang et al. 2007), begin feeding, and are more exposed to predators. A positive relationship is observed between longfin smelt abundance and Delta outflow during the designated critical outflow period for longfin smelt between December and May (Stevens and Miller 1983; Kimmerer 2002), also suggesting a relationship to estuarine salinity. Longfin smelt have salinity tolerance up to ocean salinities, but are generally found between 0–20 ppt. Like delta smelt, longfin smelt larvae, in particular, are mostly found at <10 ppt, focusing near X2 (Hobbs et al. 2010; Kimmerer 2002).

Sacramento Splittail

Sacramento splittail is a special-status species that is not listed as threatened or endangered under ESA or CESA but is a California species of special concern. Sacramento splittail support a seasonal recreational fishery.

Sacramento splittail was listed as a federally threatened species but was delisted September 22, 2003. It is a large minnow endemic to the Bay-Delta and is confined to the lower reaches of the Sacramento River and SJR, the Delta, Suisun and Napa Marshes, and tributaries of northern San Pablo Bay (Wang 1986; Moyle et al. 1995). Although the Sacramento splittail generally abides in freshwater, the adults and sub-adults have a moderate to high tolerance for saline waters (up to 10–18 ppt) and are therefore considered an estuarine species. The salt tolerance of Sacramento splittail larvae is unknown (Meng and Moyle 1995; Moyle et al. 2004).

The decline in abundance of Sacramento splittail is attributable to the loss or alteration of lowland habitats (Young and Cech Jr. 1996). Specifically, the decline in abundance has been attributed to the reduction of the Delta outflow as a result of dam construction and upstream diversions and the changes in hydrodynamics in the Delta as a result of Delta exports (CDFG 1992a; Moyle 2002). High salinities are thought to restrict the downstream range of Sacramento splittail, and without adequate Delta outflow, juveniles are not able to rear in appropriate nursery areas (Young and Cech Jr. 1996).

Sacramento splittail have a high reproductive capacity. Individuals live 5–7 years and generally begin spawning at 1–2 years. Spawning, which seems to be triggered by increasing water temperatures and hours of sunlight, occurs over beds of submerged vegetation in slow-moving stretches of water, such as flooded terrestrial areas and dead-end sloughs (Sommer et al. 1997). Large-scale spawning and juvenile recruitment occurs only in years with significant protracted (greater than or equal to 30 days) floodplain inundation (McBain and Trush 2002), particularly in the Sutter and Yolo Bypasses (Meng and Moyle 1995; Sommer et al. 1997). Spawning also occurs in perennial marshes and along vegetated edges of the Sacramento River and SJR (Moyle et al. 2004). Adults spawn from late February through early July, most frequently during March and April (Wang 1986), and occasionally as early as January (Feyrer 2004).

Hatched larvae remain in shallow, weedy areas until they move to deeper offshore habitat later in the summer (Wang 1986). Young Sacramento splittail may occur in shallow and open waters of the Bay-Delta and San Pablo Bay, but they are particularly abundant in the northern and western Delta.

The diet of Sacramento splittail larvae up to 15 mm in length is dominated by zooplankton, primarily cladocerans, with some copepods, rotifers, and chironomids present in small amounts; chironomids become important after splittail reach 15 mm in length (Kurth and Nobriga 2001; Moyle 2002). In the 1980s, the diet of splittail age 1 and above included the native mysid shrimp, *Neomysis*, amphipods, and harpacticoid copepods, with detritus accounting for more than half the diet (Feyrer et al. 2003). After the invasion of the overbite clam *Potamocorbula amurensis* in the 1980s and the crash of *Neomysis*, clams, especially *Potamocorbula*, became an important component of the diet (Feyrer et al. 2003).

Kern Brook Lamprey

Kern brook lamprey is not listed as threatened or endangered under ESA or CESA but is a California species of special concern.

This species was first discovered in the Friant-Kern Canal, but it has since been found in the lower reaches of the Merced River, Kaweah River, Kings River, and SJR downstream to Kerckhoff Dam (Wang 1986). Based on the life history of other non-parasitic brook lampreys, Kern brook lampreys are thought to live for 4–5 years as ammocoetes (larvae) before metamorphosing into adults. Principal habitats of Kern brook lamprey are silty backwaters of large rivers in the foothill regions (mean elevation = 440 ft; range = 100–1,100 ft). In summer, ammocoetes are usually found in shallow pools along the edges of runs with slight current, depths of 12–45 inches, and water temperatures rarely exceeding 25°C (77°F). Ammocoetes appear to prefer sand/mud substrate where they remain buried with the head protruding above the substrate and feed by filtering diatoms and other microorganisms from the water. Adults likely require coarser gravel-rubble substrate for spawning (Moyle et al. 1995).

River Lamprey

River lamprey is not listed as threatened or endangered under ESA or CESA but is a species of special concern in California.

The biology of the river lamprey has not been well studied in California. As a result, much of this discussion is derived from information known for river lamprey from British Columbia. Thus, timing and life history events may be dissimilar due to differences in abiotic factors that are unique to California river systems (e.g., temperature, hydrology). River lamprey appear to be more abundant in the Lower Sacramento River, LSJR, and Stanislaus and Tuolumne Rivers than in other streams in California (Moyle 2002) such as Mill Creek (Wang 1986).

River lamprey begin their migration into freshwater in the fall towards suitable spawning areas upstream. However, river lamprey can spend their entire lives in freshwater as adults (such as the land-locked population of Sonoma Creek) (Wang 1986). Spawning occurs February–May in gravelly riffles. The eggs hatch into ammocoetes that remain in fresh water for approximately 3–5 years in silty or sandy low-velocity backwaters or stream edges where they bury into the substrate and filter-feed on algae, detritus, and micro-organisms (Moyle et al. 1995; USBR 2011).

During summer, ammocoetes change into juveniles and then adults at approximately 12 centimeter (cm) TL. This process takes 9–10 months, during which individuals may shrink in length by up to 20 percent (Moyle 2002). Adults spend approximately 3–4 months in the ocean, where they grow rapidly to 25–31 cm TL. If the ammocoete stage is 3–5 years, the total life span of river lamprey is estimated to be 6–7 years (Moyle et al. 1995; Moyle 2002).

River lamprey adults are parasitic during both freshwater and saltwater phases (Wang 1986). Adults feed on a variety of host fish species that are small to intermediate size (4–12 inches TL) (Moyle et al. 1995).

California Roach

California roach are sub-divided into several subspecies, two of which occur in the Sacramento–San Joaquin River Basin: the Sacramento-San Joaquin roach and the Red Hills roach (Moyle 2002). The Sacramento–San Joaquin roach is widely distributed throughout Sacramento and SJR drainages, while the Red Hills roach is known to occur in Horton Creek and other small streams near Sonora, California, in the Tuolumne River drainage. This species is recognized as a California species of special concern.

California roach frequent a variety of habitats, are generally found in small, warm streams, and are most abundant in mid-elevation streams in the Sierra Nevada foothills. Roach are tolerant of relatively high temperatures (86°F–95°F) and low oxygen levels (1–2 parts per million [ppm]). They also thrive in cold, clear, well-aerated streams, in heavily modified habitats, and in the main channels of rivers (Brown and Moyle 1993), such as the Tuolumne River (Moyle 2002).

Roach are omnivorous and are largely benthic feeders. However, in the Tuolumne River (below Preston Falls), they feed in fairly fast current on drift organisms, such as terrestrial insects. In larger streams, such as the North Fork Stanislaus River, aquatic insects may dominate their diets year-round (Moyle 2002).

Roach usually mature after reaching 45–60 mm TL at 2–3 years of age. Spawning is from March through early July, depending on water temperature, usually occurring when temperatures exceed 16°C (60.8°F) (Moyle 2002).

Pacific Lamprey

Pacific lamprey is not listed as threated or endangered under ESA or CESA but is a federal species of concern.

In the Central Valley, Pacific lamprey occur in the Lower Sacramento River and SJR and many of their tributaries, including the three eastside tributaries (Brown and Moyle 1993). Similar to the river lamprey, the majority of Pacific lamprey spend the predatory phase of their lives in the ocean (35 ppt) (USBR 2011). Pacific lamprey begin their migration into freshwater towards upstream spawning areas primarily between early March and late June. Spawning habitat requirements are thought to be similar to those of salmonids (Moyle 2002).

Pacific lamprey construct nests in gravelly substrates at a depth of 30–150 cm with moderately swift currents and water temperatures of typically 12°C–18°C (53.5°F–64.5°F). The eggs hatch into ammocoetes after 19 days at 59°F and then drift downstream to suitable areas in sand or mud. Ammocoetes remain in fresh water for approximately 5–7 years, where they bury into silt and mud and feed on algae, organic material, and microorganisms in various locations. Ammocoetes change into juveniles when they reach 14–16 cm TL. Downstream migration begins when the change is complete and generally coincides with high flow events in winter and spring (Moyle 2002; USBR 2011).

Hardhead

Hardhead is a special-status species that is not listed as threated or endangered under ESA or CESA but is a California species of special concern.

Hardhead is widely distributed in low- to mid-elevation streams in the Sacramento River and SJR Basins, scattered in tributary streams, and absent from valley reaches of the LSJR (Brown and Moyle 1993). Hardhead is also abundant in a few mid-elevation reservoirs used largely for hydroelectric power generation, such as Redinger and Kerkhoff Reservoirs (Moyle 2002).

Optimal temperatures for hardhead are determined to be 75°F–83°F, and most streams where hardhead are present have summer temperatures in excess of 68°F. At higher temperatures, hardhead is relatively intolerant of low oxygen levels, a factor that may limit its distribution to well-oxygenated streams and reservoir surface waters (Moyle 2002). Hardhead prefers clear, deep (more than 80 cm) pools and runs with sand-gravel-boulder substrates and slow velocities (20–40 cm per second). These fish are primarily riverine or freshwater; hardhead are always found in association with Sacramento pikeminnow (*Ptychocheilus grandis*) and usually with Sacramento sucker (*Catostomus occidentalis*) (Moyle 2002). Hardhead tend to be absent from streams where introduced species, especially centrarchids, predominate (Brown and Moyle 1993).

Hardhead mature in their third year and spawn mainly in April and May (Grant and Maslin 1999). Juvenile recruitment patterns suggest that spawning may extend into August in some foothill streams. Hardhead from larger rivers or reservoirs may migrate 30–75 kilometers (km) or more upstream in April and May, usually into tributary streams (Moyle et al. 1995). In small streams, hardhead may move only a short distance from their home pools for spawning, either upstream or downstream (Grant and Maslin 1999).

Hardhead are omnivores that consume drifting insects and algae in the water column and forage for benthic invertebrates and aquatic plant material on the bottom of the river floor (Alley and Li 1977).

Largemouth Bass

Largemouth bass is not a special-status species. A nonnative, it was first introduced into California in 1874, it spread to suitable habitat throughout the state and has become an important warmwater game fish in the state (Dill and Cordone 1997; Moyle 2002).

Largemouth bass are found in warm, quiet water with low turbidity and aquatic plants, such as farm ponds, lakes, reservoirs, sloughs, and river backwaters. Adult bass remain close to shore and usually are abundant in water 1–3 m deep near submerged rocks or branches. Young-of-the-year largemouth bass also usually stay close to shore in schools but occasionally swim about in the open (Moyle 2002).

Many California reservoirs and farm ponds provide excellent largemouth bass fishing with sizable populations of large, fast-growing fish. In reservoirs, the manipulation of water levels for water supply or hydropower production influences bass populations by affecting food availability and spawning success (Moyle 2002). However, largemouth bass are largely more tolerant to environmental stressors, such as the change in water levels in reservoirs, than native special-status fishes (Schindler et al. 1997; Moyle 2002).

Largemouth bass tolerate extreme water quality conditions, such as temperatures of 96.8°F–98.6°F with dissolved oxygen (DO) concentrations as low as 1 milligram per liter. Water temperatures optimum for growth range from 77°F–86°F (Moyle 2002). Very little growth occurs at temperatures below 59°F or above 96.8°F (Stuber et al. 1982).

Optimal riverine habitat for largemouth bass consists of large, slow-moving rivers or pools with fine-grained (sand or mud) substrates, some aquatic vegetation, and relatively clear water. Optimal velocities are generally less than 0.2 feet/second (ft/s), and velocities more than 0.34 ft/s are avoided. Velocities of over 0.66 ft/s are believed to be unsuitable (Stuber et al. 1982).

Largemouth bass spawn for the first time during their second or third spring, when they are approximately 180–210 mm. Spawning begins in March or April when water temperatures reach 59°F–60.8°F and may continue through June when water temperatures up to 75.2°F (Moyle 2002; ICF International 2012). Males build nests in a wide variety of substrates, including sand, mud, cobble, and vegetation, and gravel. Gravel seems to be preferred, while silty substrates are unsuitable (Stuber et al. 1982). Rising waters in reservoirs may cause active nests to be located as deep as 4–5 m. The eggs adhere to the nest substrate and hatch in 2–5 days (Moyle 2002). They are brackish water tolerant but tend to stay in freshwater and can persist in waters with low DO content (Moyle 2002).

For the first month or two after hatching, the fry feed mainly on rotifers and small crustaceans, but by the time they are 50–60 mm, they feed largely on aquatic insects and fish fry, including those of their own species. Once largemouth bass exceed 100–125 mm, they feed principally on fishes; however, prey preferences can vary from year to year (Moyle 2002).

Striped Bass

Striped bass, an introduced species, is not a special-status species but supports a popular and economically important recreational fishery. It is considered one of the species affected by the Pelagic Organism Decline (Sommer et al. 2007).

Striped bass are native to the Atlantic Coast of North America and was introduced to California in 1879 (Dill and Cordone 1997; Moyle 2002). Since being introduced, striped bass have become widespread in the Bay-Delta as both juveniles and adults. The species can also be found in the larger river systems downstream of impassible dams and the LSJR (Baxter et al. 2008). Striped bass are anadromous, spending the majority of their lives in saltwater (35 ppt) and returning to freshwater to spawn. When not migrating, the population located in the Bay-Delta is concentrated in San Pablo Bay, San Francisco Bay, and the ocean, but only within approximately 40 miles of the Golden Gate Bridge (Moyle 2002). Striped bass spawn in the Bay-Delta and lower reaches of the Sacramento River and SJR, including their tributaries. Spawning usually begins in April or May when water temperatures reach 60°F and continues sporadically over 3–5 weeks. It peaks in May and June, depending on the interaction of three factors: temperature, flow, and salinity (Farley 1966). Optimum temperatures appear to be roughly between 59°F and 68°F. Successful spawning in the LSJR above Vernalis occurs mainly during years of high flow when the large volume of runoff dilutes salty irrigation wastewater that normally comprises much of the river flow. In years of lower flow, spawning occurs in the Bay-Delta itself. The interaction of these factors produces spawning habitat in the LSJR and the southern Delta from sloughs near Venice Island down to Antioch (Farley 1966; Moyle 2002).

Eggs hatch in approximately 2 days at 64.5°F–66°F, and the larvae stage lasts an additional 4–5 weeks. Embryos and larvae drift into the Bay-Delta[9] and disperse as they grow. Larvae and juveniles feed primarily on invertebrates but switch their diet mainly to fish when transitioning to sub-adulthood. Modeling studies indicate striped bass predation on salmonids has the potential to be high (Nobriga and Feyrer 2007; Lobonschefsky et al. 2012).

White Sturgeon

While not a special-status species, white sturgeon is a native and recreationally important species in the Bay-Delta that inhabits riverine, estuarine, and marine habitats.

Historically, white sturgeon ranged from Ensenada, Mexico, to the Gulf of Alaska. Currently, spawning populations are found in the Sacramento–San Joaquin, Columbia, Snake, and Fraser River systems (Moyle 2002). In California, white sturgeon are most abundant in the Bay-Delta and Sacramento River (Moyle 2002), but they have also been observed in the SJR system, particularly in wet years (CDFG 2002; Beamesderfer et al. 2004). Known spawning areas include the Sacramento River between the Red Bluff Diversion Dam and Jelly's Ferry Bridge (river mile [RM] 267) in areas characterized by swift currents and deep pools with gravel (CDFG 2002), and recent egg sampling surveys have detected spawning in the mainstem SJR as far upstream as Grayson (RM 142) (Jackson and Van Eenennaam 2013).

White sturgeon spend most of their lives in the brackish portions of the upper estuary, although small number of individuals move extensively in the ocean (35 ppt); they are thought to be anadromous (Moyle 2002; Welch et al. 2006). Individuals can live over 100 years and can grow to over 19.7 ft (6 m), but sturgeon greater than 27 years old and over 6.6 ft (2 m) are rare (Moyle 2002). Male white sturgeon reach sexual maturity at 10–12 years of age, and females reach sexual maturity at 12–16 years (Moyle 2002). White sturgeon can spawn multiple times throughout their lives. Males are believed to spawn every 1–2 years, whereas females spawn every 2–4 years (Moyle

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[9] Larval striped bass are associated with X2.

2002). Spawning typically occurs between February and June, when temperatures are 46°F–66°F (8°C–19°C) (Moyle 2002). Maximum spawning occurs at 58°F (14.4°C) in the Sacramento River (Kohlhorst 1976). It is thought that adults broadcast spawn in the water column in areas with swift current.

Fertilized eggs sink and attach to the gravel bottom, where they hatch after 4 days at 61°F (16°C) (Beer 1981), though hatching may take up to 2 weeks at lower water temperatures. Temperatures suitable for incubation and hatching range from 46°F to 68°F (ICF International 2012). Newly hatched larvae generally remain in the gravel for 7–10 days before emergence into the water column (Moyle 2002). Larvae are yolk sac dependent for approximately 7–10 days until the yolk sac is absorbed, at which time they begin actively feeding on amphipods and other small benthic macroinvertebrates (Wang 1986). Juvenile white sturgeon feed primarily on algae, aquatic insects, small clams, fish eggs, and crustaceans, but their diet becomes more varied with age (Wang 1986; Moyle 2002). Since the invasion by the overbite clam in the western Delta and Suisun Bay during the late 1980s, the clam has become a major component of the diet of juvenile and adult white sturgeon.

Spawning success varies from year to year, but is most likely related to temperature and Delta outflow. Spring flows in wet years may be the single most significant factor for white sturgeon year class strength (Beamesderfer et al. 2005). Although the mechanism is unknown, it is hypothesized that higher flows may help disperse young sturgeon downstream, provide increased freshwater rearing habitat, increase spawning activity cued by higher upstream flows, increase nutrients in nursery areas, or increase downstream migration rate and survival through reduced exposure time to predators (USFWS 1995).

American Shad

American shad is not a special-status species. American shad was introduced into the Sacramento River in the late 1800s and supported a commercial fishery by 1879 (Reynolds et al. 1993). Once established, American shad quickly spread into other rivers along the West Coast, including the LSJR (Dill and Cordone 1997). American shad population abundance in the Central Valley has declined from historical levels. The decline is attributed to increased water diversions and changing ocean conditions. The limited population data available also appears to indicate that American shad recruitment is lower during drier years (when Delta outflow is low) (Moyle 2002). Drought conditions are often accompanied by increases of temperature, causing juveniles rearing in the Bay-Delta and LSJR to become stressed.

The geographic distribution of American shad includes the Delta and Sacramento River, American River, Feather River, Yuba River, and SJR. Mature American shad start appearing in the LSJR in late April, with increased recruitment occurring in wetter years. Peak spawning occurs from mid-May to mid-June at water temperatures of 51.8°F–62.6°F; however, some spawning can occur as late as early September. American shad spawn mostly in main channels of rivers over a wide variety of substrates, although sand and gravel are most commonly used. Depth of the water is usually less than 3 m but can range from 1–10m. Following their first spawning event, American shad will return annually to spawn until they are up to 7 years of age (Moyle 2002).

Depending on water temperatures, larvae hatch from eggs in 3–12 days. Larval American shad are planktonic for about 4 weeks and cannot survive in saltwater (Zydlewski and McCormick 1997). The first several months are usually spent in fresh water, but small shad can live in salinities of up to

20 ppt. American shad seem to prefer temperatures of 62.6°F–77°F during the rearing stage (Stier and Crance 1985; Moyle 2002).

While in the Bay-Delta, young American shad feed on zooplankton, especially mysid shrimp, copepods, and amphipods. Although they feed primarily in the water column, they are opportunistic and will also take abundant bottom organisms and surface insects. Entry into saltwater takes place in September, October, and November, but may start as early as June, especially in wet years when outflows are high. Peak salvage of juvenile shad at the southern Delta pumping plants generally occurs during this time (Moyle 2002).

Kokanee

Kokanee is not a special-status species. It was brought from Idaho to California in 1941 (Moyle 2002). Kokanee is the nonanadromous form of sockeye salmon; individuals mature in lakes and reservoirs rather than in the ocean. Kokanee prefer well-oxygenated, open waters of lakes and reservoirs, roughly 1–3 m from the water's surface where temperatures range between 50°F and 59°F. Most kokanee populations mature in 4 years; however, populations can mature in as little as 2 years or take as many as 7 years (Moyle 2002). Like other salmonid species, once kokanee mature, they typically return to the stream in which they were hatched as fry (Moyle 2002).

Spawning behavior of kokanee is similar to that of other salmonids (e.g., mate selection, redd construction, death after spawning). Typically, kokanee spawn between August and February; however, they have been observed to spawn as late as April in California. Most spawning takes place in the gravel riffles of small streams a short distance from a lake or reservoir where temperatures are roughly 43°F–55.5°F. Fry typically emerge from the redds in April and June and immediately move to downstream rearing habitat (Moyle 2002).

7.2.2 Reservoirs, Tributaries, and LSJR

This section describes the water bodies comprising the environmental setting for aquatic resources that may be affected by the LSJR alternatives. These water bodies are the major storage reservoirs on the Stanislaus, Tuolumne, and Merced Rivers; the downstream reaches of the Stanislaus, Tuolumne, and Merced Rivers below the rim dams; and the LSJR and southern Delta. For each water body, the indicator species and the baseline environmental stressors affecting aquatic resources are discussed. Table 7-4 summarizes the indicator species found in these geographic locations and their life stages.

Efforts to protect aquatic resources in the SJR Basin, outside the plan area, are currently underway. As discussed in Appendix K, *Revised Water Quality Control Plan*, SJRRP is currently undertaking the restoration of flow to the Upper SJR from Friant Dam to the confluence with the Merced River to restore a self-sustaining Chinook salmon fishery in the river, while reducing or avoiding adverse water supply impacts from restoration flows. Major planning and permitting activities are currently underway, as well as studies and monitoring activities to evaluate the current and future needs of fish in the river The State Water Resources Control Board (State Water Board) will continue to coordinate adaptive implementation and future changes to the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacrament–San Joaquin Delta Estuary* (2006 Bay-Delta Plan) with the SJRRP to assure the protection of fish and wildlife in the SJR Basin. Following full implementation of the SJRRP, the State Water Board will also evaluate whether additional changes should be made to flow, water right, or other requirements to protect fish and wildlife in the SJR.

Stanislaus River

New Melones Reservoir

New Melones Reservoir supports sport fisheries for coldwater and warmwater species, including rainbow trout, brown trout, kokanee, largemouth bass, smallmouth bass, crappie (*Pomoxis* spp.), bluegill (*Lepomis macrochirus*) catfish, minnows, suckers, and carp. Rainbow and brown trout are generally restricted to colder, deeper water during summer, while most of the other species inhabit warmer surface and shallow inshore waters (USBR 2009).

Stanislaus River below New Melones Reservoir

Historically, spring-run Chinook salmon, fall-run Chinook salmon, Central Valley steelhead, and possibly late fall-run Chinook salmon occurred in the Stanislaus River (Yoshiyama et al. 1996, 1998). Salmon and steelhead were abundant in the Merced and Tuolumne Rivers and presumably the Stanislaus River before the Gold Rush began in 1849. Populations declined thereafter in response to dam construction, expansion of commercial fishing, and habitat degradation associated with early hydraulic mining, dredging, and water diversions. Spring-run Chinook salmon are thought to have been extirpated from the Stanislaus River after the construction of Melones Dam in 1926, which blocked access to their historical spawning habitat in the upper watershed (Yoshiyama et al. 1996, 1998). Goodwin Dam, completed in 1913, was passable but became a complete barrier to migration by 1940 and is now the upstream limit of migration for anadromous fish (Stanislaus River Fish Group 2003). These barriers likely had a similar effect on steelhead because of steelhead's dependence on higher elevation streams for holding, spawning, and early rearing.

Today, the only anadromous salmonids in the Lower Stanislaus River supports are fall-run Chinook salmon and steelhead, both of which are currently restricted to the lowermost 58 RMs below Goodwin Dam. Small numbers of adult salmon are observed in the summer, but these may be spring-run strays from the Sacramento River Basin based on the recovery of tagged adults originating from the Feather River Hatchery (Stanislaus River Fish Group 2003). Other anadromous fish species that occur in the Lower Stanislaus River include striped bass, American shad, Pacific lamprey, and river lamprey (Stanislaus River Fish Group et al. 2003). Striped bass and American shad were introduced into the Sacramento and SJR Basin in the late 1880s (Stanislaus River Fish Group et al. 2003).

Table 7-4. Geographic and Seasonal Occurrence of Indicator Fish Species and Life Stages

Life Stage	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central Valley fall-run Chinook salmon													
Adult migration	Bay-Delta, SJR and three eastside tributaries							░	░	░	▓	▓	░
Spawning/incubation	Three eastside tributaries	░	░	░						░	▓	▓	▓
Juvenile rearing/emigration	Bay-Delta, SJR and three eastside tributaries	░	▓	▓	▓	▓	░						
Central Valley steelhead													
Adult migration	Bay-Delta, SJR and three eastside tributaries	▓	▓	░				░	░	░	▓	▓	▓
Spawning/incubation	Three eastside tributaries	▓	▓	▓	░								░
Juvenile rearing	Three eastside tributaries	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓
Juvenile emigration (age 1+)	Bay-Delta, SJR and three eastside tributaries	░	▓	▓	▓	▓	░						
Rainbow trout													
Adult migration (lake to stream)	New Melones, New Don Pedro, Lake McClure and Lake McSwain	░											░
Spawning/incubation	Three eastside tributaries		▓	▓	▓	░	░						
Juvenile rearing	Three eastside tributaries	░	░	░	░	░	░	░	░	░	░	░	░
Largemouth bass													
Spawning/incubation	Bay-Delta, SJR and three eastside tributaries, and reservoirs				▓	▓	▓						
Juvenile rearing to adult	Bay-Delta, SJR and three eastside tributaries, and reservoirs	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓

▓ Primary occurrence periods considered in impact assessment.

░ Non-primary occurrence period.

Sources: Adapted from Rosenfield and Baxter 2007; Wang and Brown 1993; USFWS 1996; McEwan 2001; Moyle 2002; Hallock 1989; and USBR 2011.
Note: Federal ESA list accessed January 12, 2012; CDFW special status list accessed January 12, 2012.

Indicator Species

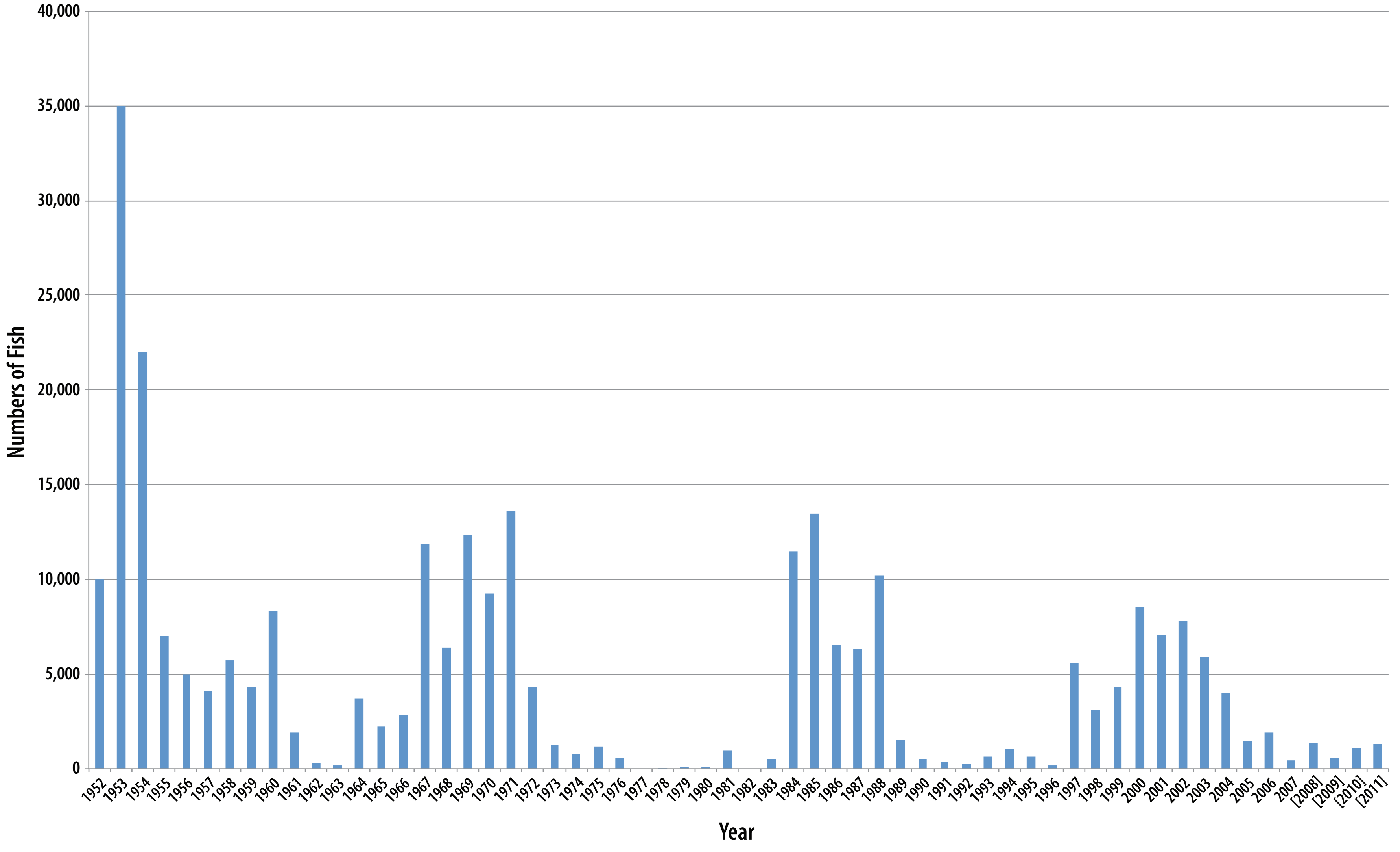
Fall-Run Chinook Salmon

The fall-run Chinook salmon population of the Stanislaus River is maintained by natural production and hatchery strays originating from the Merced River, Mokelumne River, and Sacramento River Basin hatcheries. The California Department of Fish and Wildlife (CDFW [formerly California Department of Fish and Game (CDFG)]) began estimating the number of fall-run Chinook salmon that returned to spawn each year (i.e., spawning escapement) in the Stanislaus River in 1947 (Stanislaus River Fish Group 2003). Since 1947, annual escapement to the Stanislaus River has fluctuated substantially with the highest returns generally occurring during wet periods or after years of relatively high spring flows and the lowest returns generally occurring during dry periods or after years of relatively low flows (Figure 7-1).

Annual escapement of fall-run Chinook salmon was minimally estimated at 4,000–35,000 spawners (average about 11,100) from 1946–1959 before the construction of Tulloch Dam in 1959. In the following 12-year period (1960–1971), the average run size was about 6,000 fish. Fall-run abundances during the 1970s and 1980s ranged up to 13,600 (average about 4,300) spawners annually (CDFG unpublished data). The numbers of spawners returning to the Stanislaus River have been especially low during most of the 1990s—<500 fish annually in 1990–1993, 600–800 fish in 1994–1995, and <200 fish in 1996—but there was a modest increase to 1,500 spawners in 1997 and 2,200 spawners in 1998 (CDFG unpublished data) (Figure 7-1). Estimation of the proportion of hatchery- and natural-origin fall-run Chinook salmon returning to the Central Valley in recent years indicates that returns to the Stanislaus River are dominated by hatchery-origin fish. In 2011, an estimated 83 percent of the run were hatchery-produced fish originating primarily from Mokelumne River Hatchery, Coleman National Fish Hatchery, and Merced River Hatchery (Palmer-Zwahlen and Kormos 2013). Juvenile salmon may occur throughout the Stanislaus River below Goodwin Dam during the primary rearing and emigration period (February–May). Monitoring of downstream movements of juvenile Chinook salmon at Oakdale and Caswell from 1996–2005 revealed a consistent migration pattern characterized by downstream dispersal of newly emerged fry from late January through early March, followed by the emigration of smaller numbers of parr and smolts through mid-June. Peak movements of juveniles generally coincided with rapid increases or peaks in flow (i.e., flow pulses), especially during the fry emigration period (Pyper and Justice 2006).

Steelhead

Steelhead were thought to have been extirpated from their entire historical range in the San Joaquin Valley, but current populations consisting of anadromous and non-anadromous forms survive in the Stanislaus, Tuolumne, and Merced Rivers (NMFS 2009a). Information regarding steelhead numbers on the Stanislaus River is scarce and has typically been gathered incidental to existing monitoring activities for fall-run Chinook salmon. For example, in 2006–2007, 12 steelhead were observed passing through the counting weir (NMFS 2009c). Steelhead smolts have been captured in rotary screw traps at Oakdale and Caswell State Park since 1995 (S. P. Cramer and Associates Inc. 2000, 2001), but the numbers are very low, ranging from 10–30 annually. Most of the steelhead smolts are captured from January to mid-April at a size of 175–300 mm fork length. The distribution and habitat preferences of spawning adults in the Stanislaus River are unknown, but it is presumed that the majority of spawning occurs between Goodwin Dam and Orange Blossom Bridge.



Source: CDFG, GrandTab

Note: 2008-2011 data are preliminary

Graphics…00427.11 (8-13-2014)

Figure 7-1
Estimates of Annual Escapement of Fall-run Chinook Salmon in the Stanislaus River from 1952 to 2011

Most of the environmental factors that potentially limit survival and production of fall-run Chinook salmon in the Stanislaus River likely apply to steelhead to some degree. However, because juvenile steelhead rear in the river for 1 or more years before migrating to the ocean, steelhead also require suitable flows and temperatures during the summer months.

Environmental Stressors

Baseline stressors that affect aquatic resources in the Stanislaus River include impassable dams and alteration of the natural flow regime, loss of natural riverine function and morphology, agricultural and urban land uses, gravel mining, predation, and water quality (e.g., contaminants and suspended sediment) (NMFS 2009c).

Flow Regulation

Flow releases for fishery purposes in the Lower Stanislaus River are designated in a 1987 agreement, the New Melones Interim Plan of Operations (IPO) between the U.S. Bureau of Reclamation (USBR) and CDFG. The IPO specifies interim annual flow allocations for fisheries 98,300–302,100 AF, depending on carryover storage at New Melones Reservoir and inflow. Additional flow regulation efforts exist for the Stanislaus River, including D-1422,[10] which imposes flow requirements to provide water quality control and maintain monthly total dissolved solids (TDS) concentration. The Anadromous Fish Restoration Program (AFRP) recommended a instream flow schedule that increased flows during the spring outmigration period (February–May) and was expected to double salmon production for the SJR Basin. The National Marine Fisheries Service (NMFS) biological opinion (BO) Stanislaus River reasonable and prudent alternative, including Action 3.1.3 (NMFS BO) provides a minimum flow schedule measured at Goodwin Dam; and the U.S. Army Corps of Engineers (USACE) provides flood control release limits. (For a discussion of the flows, see Chapter 2, *Water Resources*; Chapter 5, *Surface Hydrology and Water Quality*; and Chapter 3 of Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*).

The historical relationship between spring flows during the Chinook salmon rearing and emigration period and subsequent adult abundance has been the basis for a number of analyses and experimental investigations aimed at understanding the factors influencing the population dynamics of Chinook salmon populations in the Stanislaus, Tuolumne, and Merced Rivers (see Appendix C, Chapter 3, *Scientific Basis for Developing Alternative San Joaquin River Flow Objectives*). These investigations suggest that flow in the SJR and the three eastside tributaries has a major influence on juvenile salmon survival between March and June as individuals complete the freshwater rearing, smoltification, and migration stages of their lifecycles.

Habitat Alteration

Since New Melones Dam was constructed in 1979, the quantity and quality of spawning and rearing habitat has also been adversely affected by reductions in the frequency of bed-mobilizing and channel forming flows. The effects include encroachment of riparian vegetation, increased channel

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[10] State Water Board's Water Right Decision 1422 (D-1422) approved the permits for USBR's New Melones Reservoir on the Stanislaus River and conditioned the permits on meeting total dissolved solids of 500 parts per million (ppm) (833 mmhos/cm electrical conductivity [EC]) on the SJR at Vernalis.

incision and bed armoring, and reductions in recruitment of spawning gravel to the active channel (Kondolf et al. 2001).

Impaired geomorphic processes associated with gravel mining and controlled flow releases as a result of dam operations are considered a major stressor on aquatic resources in the Stanislaus River. Historical gravel mining (dredged river channels and mine pits) and the cessation of gravel recruitment from upstream sources have reduced the availability of spawning gravel in the Stanislaus River below Goodwin Dam. Currently, fall-run Chinook salmon are known to spawn in a 23-mile stretch of the Stanislaus River downstream of Goodwin Dam, but most spawning occurs in the first 10 miles below New Melones Dam (USBR 2011). Since 1997, gravel replenishment projects have increased the amount of spawning habitat, but redd superimposition continues to be a problem and may limit the number of adult salmon that can successfully spawn in the Stanislaus River (Stanislaus River Fish Group 2003). Gravel replenishment projects have offset some habitat loss, but the rate of replenishment is neither sufficient to offset ongoing loss rates nor to offset losses from past years of operations (NMFS 2009c).

Flood attenuation, channel incision, and agricultural and urban encroachment have also reduced the frequency of overbank flows and the availability of floodplain habitat for salmon rearing and other ecosystem functions on the Stanislaus River (NMFS 2009c). Losses and degradation of riparian and floodplain habitat and reductions in natural hydrologic variability that connect rivers to their floodplains has been identified as a major stressor on native Central Valley fish populations through direct impacts on spawning and rearing habitat availability and indirect impacts on aquatic productivity and food web support provided by seasonal floodplain inundation (see Appendix C, *Technical Report on the Scientific Basis for Alternatives San Joaquin River Flow and Southern Delta Salinity Objectives*). Although specific food web studies have not been conducted on the Stanislaus River, current research indicates that regulated flows downstream of dams and losses of overbank flooding have likely contributed to historical declines and current limitations on native fish populations through reductions in primary and secondary production (phytoplankton and invertebrate production) associated with seasonal floodplain inundation (Sommer et al. 2004; Ahearn et al. 2006).

Water Quality

Land uses adjacent to the Stanislaus River and within its watershed influence the water quality of the river and the types and quantities of pollutants found in the water. Poor water quality associated with agricultural runoff (i.e., pesticides) and increasing urbanization has been identified as a potential stressor on steelhead and other aquatic resources in the Lower Stanislaus River. Common pollutants include nutrients from agricultural and livestock operations; pesticides, herbicides, and fungicides applied to crops and orchards; sediment and soil from runoff of agricultural operations; oil or grease from junkyards along the river; and trace metals, heavy metals, and sediment from historical and current mining or gravel extraction operations (NMFS 2009a). Water quality impairments for the Stanislaus River below New Melones Reservoir include diazinon, group A pesticides,[11] and mercury. Additionally, chlorpyrifos and water temperature may also be added to

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[11] Group A pesticides include one or more of the following compounds: Aldrin, Dieldrin, Endrin, Chlordane, Lindane, Heptachlor, Heptachlorepoxide, and Endosulfan and Toxaphene.

the impaired water bodies 303(d) list[12] (see Section 7.3.2, *State [Regulatory Background]*) as water quality impairments in the future.

Introduced Species and Predation

The establishment and expansion of nonnative species in the Stanislaus River, and the SJR Basin in general, has contributed to increases in potential predation-related mortality of native species such as fall-run Chinook salmon and steelhead. Striped bass, smallmouth bass, and largemouth bass are only a few of the introduced species that prey on salmonids, but they may be responsible for much of the increased predation pressure on special-status fish species compared to historical conditions (USDOI 2008). Alteration of the stream channel by the creation of ditch-like channels from historical gravel mining has also improved habitat conditions and predation opportunities for striped bass, largemouth bass, and other predatory fishes that might contribute to low survival of juvenile salmon as they migrate downstream through the lower reaches of the Stanislaus River (Grossman et al. 2013). However, exact estimates in this system need further study, and approximately 9 percent of winter-run Chinook salmon in the Central Valley are thought to be predated depending on time of migration (Loboschefsky et al. 2012; Grossman et al. 2013).

Disease

Diseased fish are present and have been caught in the Stanislaus River. Naturally produced Chinook salmon juveniles caught in rotary screw traps were diagnosed with the causative agent of bacterial kidney disease (BKD), *Renibacterium salmoninarum.* Additionally, columnaris disease, caused by the bacterium *Flexibacter columnaris*, was observed in juvenile Chinook salmon in 2007. This disease can rapidly increase in the population as water temperatures reach a mean daily temperature of 68°F–69.8°F (Nichols and Foott 2002).

Tuolumne River

New Don Pedro Reservoir

New Don Pedro Reservoir provides a warmwater and coldwater sport fishery. A variety of game fish are stocked in the reservoir. Warmwater game fish in the reservoir are a Florida strain of largemouth bass, smallmouth and spotted bass, channel catfish, crappie, sunfish, blue gill, and carp. Coldwater game fish in the reservoir are kokanee; Chinook salmon; and brown, brook, and rainbow trout (Don Pedro Lake 2012).

Tuolumne River below New Don Pedro Reservoir

Historically, the Tuolumne River had 99 miles of anadromous fish habitat, and currently there is approximately 47 miles of accessible habitat (USFWS 2008). La Grange Dam is the upstream extent of accessible anadromous fish habitat. Historically, the Tuolumne River supported abundant populations of Central Valley steelhead and fall-run and spring- run Chinook salmon (Yoshiyama et al. 1996) and now supports smaller populations of steelhead and fall-run Chinook salmon (NMFS 2009c). Spring-run Chinook salmon were extirpated from the Tuolumne River Watershed when dam construction eliminated access to upstream habitats (Stillwater Sciences n.d.). Central Valley steelhead were thought to have been extirpated from the Tuolumne River, but fisheries monitoring

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[12] Clean Water Act section 303(d) requires states, territories, and authorized tribes to develop a ranked list of water quality limited segments of rivers that do not meet water quality standards.

for the New Don Pedro Federal Energy Regulatory Commission (FERC) relicensing project have documented the presence of *O. mykiss* in the Lower Tuolumne River (TID and MID 2012).

The mainstem Tuolumne supports both nonnative and native fish species. Nonnative fish species important for sport fisheries include American shad, catfish species, largemouth, smallmouth and striped bass, and sunfish species. Native fish species include Pacific and river lamprey, hardhead, Sacramento pikeminnow, Sacramento blackfish, and Sacramento sucker (TID and MID 2012).

Indicator Species

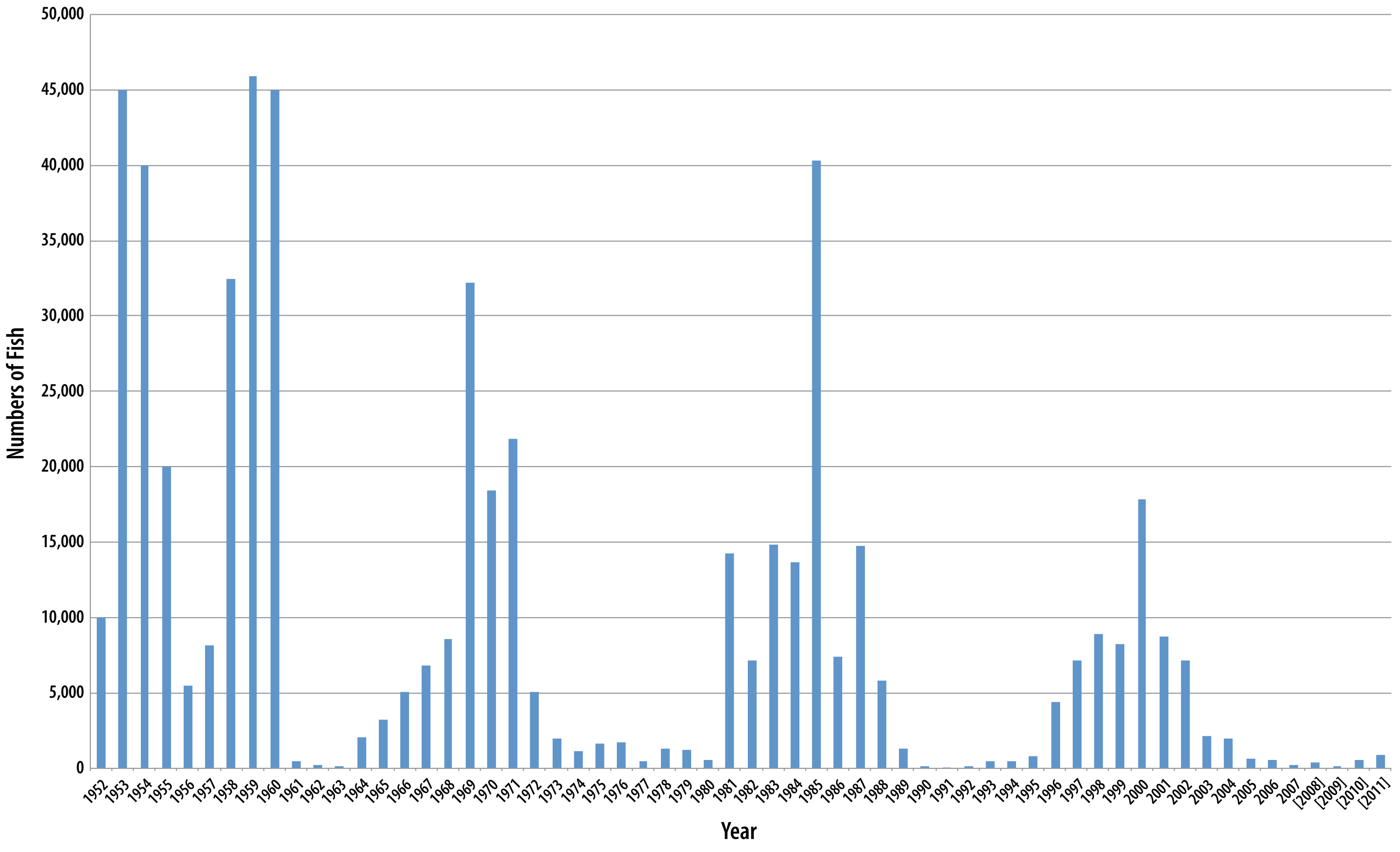
Fall-Run Chinook Salmon

The fall-run Chinook salmon population is maintained by natural production and hatchery strays from the Merced River and other basin hatcheries. Since 1960, annual escapement to the Tuolumne River has fluctuated substantially, with the highest returns generally occurring during wet periods or after years of relatively high spring flows and the lowest returns generally occurring during dry periods or after years of relatively low flows (Figure 7-2). Tuolumne River Chinook salmon estimates have ranged from a high of 45,900 fish in 1959 to a low of 77 in 1991. The population estimate for 2011 was 893 fish (CDFG unpublished data). Estimation of the proportion of hatchery- and natural-origin fall-run Chinook salmon returning to the Central Valley in recent years indicates that returns to the Tuolumne River are dominated by hatchery-origin fish. In 2011, an estimated 73 percent of the run consisted of hatchery-produced fish that originated primarily from the Merced River Hatchery, Mokelumne River Hatchery, and Feather River Hatchery (Palmer-Zwahlen and Kormos 2013).

Spawning in the Tuolumne River has been observed mainly upstream of Hickman Bridge. Spawning is most heavily concentrated in the reach between RM 51.5 (upstream of Old La Grange Bridge) and Basso Bridge. Adult Chinook salmon in the Tuolumne River generally spawn September–December, but some later-arriving fish have been observed. Recent observations of fry emergence in late May suggest that adults spawn as late as February. Also, in 2000, adults were observed in the river during summer (Stillwater Sciences n.d.). Fry emergence extends primarily from January–March (McBain & Trush 2000). Juvenile Chinook salmon leave the river as fry, juveniles, smolts (subyearlings), or yearlings. Large numbers of fry leave the river particularly during wet years. Smolts emigrate February–June. A few salmon spend summer in the river and emigrate during the fall and early winter as yearlings (Stillwater Sciences n.d.).

Steelhead

The historical distribution of steelhead in the SJR Basin, including the Tuolumne River, is poorly known, but steelhead were recorded by CDFG in counts conducted at Dennett Dam (RM 16.2) in 1940 and 1942 (CDFG unpublished data). O. mykiss population estimate snorkeling surveys started in July 2008, pursuant to an April 2008 FERC order, and ended September, 2011. The estimated population results are shown in Table 7-5 (TID and MID 2012).



Source: CDFG, GrandTab

Note: 2008-2011 data are preliminary

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Figure 7-2
Estimates of Annual Escapement of Fall-run Chinook Salmon in the Tuolumne River from 1952 to 2011

Table 7-5. Estimated Population of *O. Mykiss* from Turlock Irrigation District and Modesto Irrigation District (2012) Snorkel Surveys

Date	Number of Juveniles	Number of Adults
July 2008	2,472	643
March 2009	63	170
July 2009	3,475	963
March 2010	0	109
August 2010	2,405	2,139
September 2011	47,432	9,541

An acoustic tag and tracking survey was done pursuant to a May 2010 FERC Order. *O. mykiss* were tagged with acoustic tags and tracked to determine spawning locations, migration patterns, and potential habitat use of restored river reaches. Tracking began in 2010 and continued into 2011. No other fish were tagged in 2011. All tagged fish remained in the river. Two tagged fish moved up- and downstream as far as 6.8 miles, and all other fish remained near their release locations (TID and MID 2012).

Environmental Stressors

Anthropogenic factors have affected salmonid habitat on the Tuolumne River. Water supply development, flood control, gold dredging, aggregate mining, and hatchery operations have all affected salmonid populations (Stillwater 2002).

Flow Regulation

Available fish habitat on the Tuolumne River is primarily controlled by established flows. Flow requirements for the Lower Tuolumne River are specified in the *New Don Pedro Proceeding Settlement Agreement* and the *FERC License Amendment for the New Don Pedro Project*. These flows are provided to protect fall-run Chinook salmon spawning below La Grange Dam. (For a discussion of the flows, see Chapter 2, *Water Resources*; Chapter 5, *Surface Hydrology and Water Quality*; and Appendix C, Chapter 3, *Scientific Basis for Developing Alternative San Joaquin River Flow Objectives*).

The historical relationship between spring flows during the juvenile emigration period and subsequent adult abundance has been the basis for a number of analyses and experimental investigations aimed at understanding the factors influencing salmon survival and population dynamics under historical and recent water management operations in the SJR and Delta (see Appendix C, Chapter 3, *Scientific Basis for Developing Alternate San Joaquin River Flow Objectives*). These investigations suggest that flow in the SJR and the three eastside tributaries has a major influence on juvenile salmon survival between March and June as individuals complete the freshwater rearing, smoltification, and migration stage of their lifecycles.

Habitat Alteration

Habitats in the Tuolumne River downstream from LaGrange Dam have been influenced and altered by former gold mining activities and gravel mining (USBR 2011). As a result, there is limited spawning habitat in upstream areas, and this results in redd superimposition and egg mortality (Stillwater Sciences n.d.; Moyle 2002). During the early twentieth century, the Tuolumne River channel and floodplain were dredged for gold. The gold dredges excavated channel and floodplain deposits to the depth of bedrock (approximately 25 ft [7.6 m]) and often realigned the river channel. Due to gravel mining activities, the channel has become constrained by dredge tailings, which restricts channel meander and reduces delivery of gravel to the river. Riparian vegetation is also scarce due to dredge tailings. By the end of the gold mining era, the floodplain adjacent to 12.5 miles (20 km) of the river (RM 50.5–38) had been converted to tailings deposits. Tailings remain in the reach from RM 45.4–40.3 (Stillwater Sciences n.d.). Additionally, pits were made in the channel that provide habitat for largemouth bass and other predatory fish species.

Land clearing for gold dredging, aggregate mining, and agricultural and urban development has resulted in the loss of 85 percent of the Tuolumne River's historical riparian forest. Vegetation that once extended from bluff to bluff prior to the Gold Rush is now confined to a narrow band along the active channel margins in many areas, or is nonexistent. Nearly all of the areas in the gravel-bedded zone that historically supported riparian forests have been mined, grazed, or farmed (Stillwater Sciences n.d.).

Under the FERC settlement agreement, habitat restoration has begun on the Lower Tuolumne River. A total of 14 channel restoration projects have been identified in the *Habitat Restoration Plan for the Lower Tuolumne River Corridor* (McBain and Trush 1999). From reach RM 0–52, which is below La Grange Dam, general restoration components include restoring floodplain habitat, planting riparian vegetation along the banks, and adding spawning gravel to reaches of the river that are conducive to spawning (USFWS 1999). Between 1994 and 2003, 19,250 cubic yards of gravel were added to enhance spawning and rearing habitats in the Tuolumne River (Table 7-6).

Table 7-6. Tuolumne River Gravel Augmentation Projects

Tuolumne River Projects	Gravel Volume Added (yard^3)	Year Construction Completed
La Grange Gravel Addition Project, early	6,750	1994
La Grange Gravel Addition Project, Phases I and II	12,500	1999–2003

Source: Mesick and Marston 2007.

Reductions of the magnitude, frequency, and duration of flood flows and confinement of the natural floodway of the Tuolumne River has disrupted the natural processes creating high-quality salmon spawning and rearing habitat, including shallow, slow-water river margins and floodplain habitat supporting rearing juveniles and other native fishes (McBain and Trush 2000). Losses and degradation of floodplain habitat and reductions in natural hydrologic variability that connect rivers to their floodplains has been identified as a major stressor on native Central Valley fish populations through direct impacts on spawning and rearing habitat availability and indirect impacts on aquatic productivity and food web support provided by seasonal floodplain inundation (see Appendix C, *Technical Report on the Scientific Basis for Alternatives San Joaquin River Flow and Southern Delta Salinity Objectives*). Although specific food web studies have not been conducted in the Tuolumne River, current research indicates that regulated flows downstream of dams and losses of overbank flooding have likely contributed to historical declines and current limitations on native fish populations through reductions in primary and secondary production (phytoplankton and invertebrate production) associated with seasonal floodplain inundation (Sommer et al. 2004; Ahearn et al. 2006).

Water Quality

As discussed for the Stanislaus River, land uses adjacent to and within the watershed influence the water quality of the river and the types and quantities of pollutants found in the water. Poor water quality associated with agricultural runoff and increasing urbanization has been identified as a potential stressor on steelhead and other aquatic resources in the Lower Tuolumne River. Common pollutants include nutrients from agricultural and livestock operations; pesticides, herbicides, and fungicides applied to crops and orchards; sediment and soil from runoff of agricultural operations; oil or grease from junkyards along the river; and trace metals, heavy metals, and sediment from historical and current mining or gravel extraction operations (NMFS 2009a).

Introduced Species and Predation

Studies of predator abundance, habitat use, and predation rates on juvenile Chinook salmon in the Tuolumne River indicate that predation by largemouth bass, smallmouth bass, and other nonnative fishes may be a limiting factor for Chinook salmon outmigrant survival and may be a source of mortality under low flow conditions (EA 1992; TID and MID 1992; FishBio 2013). In general, reduced spring flows, elevated water temperatures, and the presence of low-velocity habitats (including former in-channel aggregate mining pits) in the lower reaches of the Tuolumne River favor fish communities dominated by nonnative, warmwater species such as largemouth bass and other potential predators on native salmonids (EA 1992; McBain and Trush 2000; Brown and Ford 2002). For example, Brown and Ford (2002) found that the spawning success of nonnative species, as measured by the proportion of nonnative juveniles (consisting predominantly of bass and sunfish species) in winter and spring samples, was inversely related to spring discharge the previous year (Brown and Ford 2002). The response of nonnative warmwater fish species to high spring flows also included a downstream shift in distribution consistent with the hypothesized effect of higher flows and lower water temperatures on spawning success (Stillwater Sciences et al. 2006).

Hatchery Operations

As discussed above, large numbers of unmarked hatchery salmon are released into the Merced River each year and may stray into the Tuolumne River. In recent years, up to 200,000 hatchery-origin salmon from the Merced River Hatchery have been released annually in the Tuolumne River. As a result, a significant number of hatchery-origin Merced River salmon return to the Tuolumne River each year. Fish produced by the hatcheries have the potential to negatively affect natural fall-run Chinook salmon by displacing wild salmonid juveniles through competition and predation, competing with natural adults for limited resources, and hybridizing Central Valley Chinook salmon with fish from outside the SJR Basin (CDFG 2011a).

Disease

Fish species on the Tuolumne River are susceptible to similar diseases as those discussed for fish in the Stanislaus River. The causative agent of BKD was detected in naturally produced juveniles caught in rotary screw traps from Tuolumne River (Nichols and Foott 2002).

Merced River

Lake McClure and Lake McSwain

Lake McClure, which is impounded by New Exchequer Dam, and Lake McSwain, which is impounded by McSwain Dam, both support warmwater and coldwater sport fish species. Lake McClure contains a variety of sport fish species, such as largemouth bass, spotted bass, bluegill, green sunfish, kokanee, rainbow trout, and Chinook salmon. Common carp and catfish are also in the reservoir (Merced ID 2011). CDFW annually stocks rainbow trout, kokanee, and Chinook salmon. Spawning habitat for warmwater fish species is available in low gradient areas in Lake McClure. Spawning gravels in six tributaries surrounding the reservoir could provide spawning habitat for both warmwater and coldwater species. Lake McSwain has the same fish species, but also contains brook and brown trout (Merced ID 2011).

Merced River below Crocker-Huffman Dam

As with the Stanislaus and the Tuolumne Rivers, the Merced River historically supported abundant populations of coldwater fish species, such as Central Valley steelhead and spring- and fall-run Chinook salmon. Chinook salmon may have occurred up to an elevation of 2,000 ft near El Portal. By 1925, Crocker-Huffman, Merced Falls, and New Exchequer Dams had blocked anadromous fish passage (Stillwater Sciences 2002). Crocker-Huffman and Merced Falls dams have fish ladders, but they were shut down when the Merced River Hatchery was constructed at the base of Crocker-Huffman Dam. These barriers likely had a similar effect on steelhead because of their dependence on higher elevation streams for holding, spawning, and early rearing (Stillwater Sciences 2002).

Today, the river supports only fall-run Chinook salmon and a small population of wild and hatchery steelhead. Currently, the Merced River is accessible to anadromous fishes for the first 51 RMs, with access terminating at Crocker-Huffman Dam (USBR 2011). There are also limited numbers of hatchery-reared, late-fall-run Chinook that have strayed from their natal streams. The Merced River Hatchery, which has been operated by CDFW since 1971, produces fall-run Chinook salmon that are released into the Merced River and used for studies throughout the SJR Basin (Stillwater Sciences 2002).

There is a variety of introduced fish species in the mainstem Merced River, including catfish, several species of bass, sunfish, American shad, threadfin shad, and carp. Native fish species include Sacramento sucker, prickly sculpin, Sacramento blackfish, Sacramento pikeminnow, Pacific and Kern Brook lamprey, hardhead, and Sacramento splittail (Stillwater Sciences 2002).

Indicator Species

Fall-Run Chinook Salmon

Since the 1940s, CDFW has conducted escapement surveys to document the number and timing of adult Chinook salmon returning to the Merced River to spawn. Since 1998, CDFW, with funding from the Central Valley Project Improvement Act–Comprehensive Monitoring and Assessment Program, also operated a rotary screw trap near the mouth of the river to document juvenile salmon outmigration and abundance (Stillwater Sciences 2002).

Annual escapement for fall-run fish has fluctuated from a high of 29,749 in 1984 to 82 adults in 1990. Before 1966, the population was less than 500 fish until minimum instream flows were established under the Davis-Grunsky Act in October of 1966 and the Merced River Hatchery opened in 1970 (Mesick 2010a). Escapement from 2007 to 2009 declined to an average of about 500 fish, presumably because of poor ocean conditions (Lindley et al. 2009). The population estimate in 2011 was 1,942 fish. Figure 7-3 shows the annual escapement of fall-run Chinook salmon from 1952 to 2011 (CDFG unpublished data). Estimation of the proportion of hatchery- and natural-origin fall-run Chinook salmon returning to the Central Valley in recent years indicates that returns to the Merced River are dominated by hatchery-origin fish. In 2011, an estimated 88–89 percent of the returns to the Merced River and Merced River Hatchery were hatchery-produced fish originating primarily from Merced River Hatchery, Mokelumne River Hatchery, and Coleman National Fish Hatchery (Palmer-Zwahlen and Kormos 2013).

Merced River fall-run Chinook salmon migrate upstream October–December and spawn through January (Stillwater Sciences 2002). Most spawning habitat is within the 24-mile reach of the Merced River between the Crocker-Huffman Dam and the town of Cressy, with rearing habitat extending downstream to the SJR confluence (USBR 2011). The majority of spawning occurs upstream of State Route 59 bridge (RM 42) (Yoshiyama et al. 2000).

Juvenile Chinook salmon rear in the river mainly between February and May, but some fish stay year-round (Yoshiyama et al. 2000). Outmigration of juveniles 0+ age (fry) occurs from January through the beginning of June. Outmigration of 1+ age fish (smolts) occurs November–February.

Steelhead

Steelhead have been captured in the rotary screw traps (Stillwater Sciences 2002), but no population estimates have been done on the Merced River. The distribution and habitat preferences of spawning adults in the Merced River is unknown, but it is presumed that the majority of spawning occurs between Crocker-Huffman Dam and the town of Cressey. Timing of adult and juvenile migration is unknown.

Most of the environmental factors that potentially limit survival and production of fall-run Chinook salmon in the Merced River likely apply to steelhead to some degree. However, because juveniles rear in the river for 1 or more years before migrating to the ocean, steelhead also require suitable flows and temperatures during the critical summer months.

Environmental Stressors

Anthropogenic factors have affected salmonid habitat on the Merced River. Water supply development, flood control, gold dredging, aggregate mining, bank stabilization, and hatchery operations have all affected salmonid populations (Stillwater 2002).

Flow Regulation

Available fish habitat on the Merced River is primarily controlled by established flows. FERC License No. 2179 for the New Exchequer project and the Davis-Grunsky Contract No. D-GG417 mandate streamflows for fishery purposes in the Lower Merced River. (For a discussion of the flows, see Chapter 2, *Water Resources*; Chapter 5, *Surface Hydrology and Water Quality*; and Appendix C, T*echnical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*). Several dams and reservoirs control flows on the mainstem Merced River, two of which are Lake McClure (impounded by New Exchequer Dam) and Lake McSwain (impounded by McSwain Dam). Lake McClure is regulated by USACE to maintain space in Lake McClure for incoming flood flows and limit the amount of water that can be released to the lower river (Stillwater 2002). Also, USACE influences flows by establishing flood control release limits for the Merced River not to exceed 6,000 cubic feet per second (cfs) downstream of Dry Creek.

The historical relationship between spring flows during the juvenile emigration period and subsequent adult abundance has been the basis for a number of analyses and experimental investigations aimed at understanding the factors influencing salmon survival and population dynamics under historical and recent water management operations in the SJR and Delta (see Appendix C, Chapter 3, *Scientific Basis for Developing Alternate San Joaquin River Flow Objectives*). These investigations suggest that flow in the SJR and the three eastside tributaries has a major influence on juvenile salmon survival between March and June as individuals complete the freshwater rearing, smoltification, and migration stages of their lifecycles (Moyle 2002; Merced ID 2011).

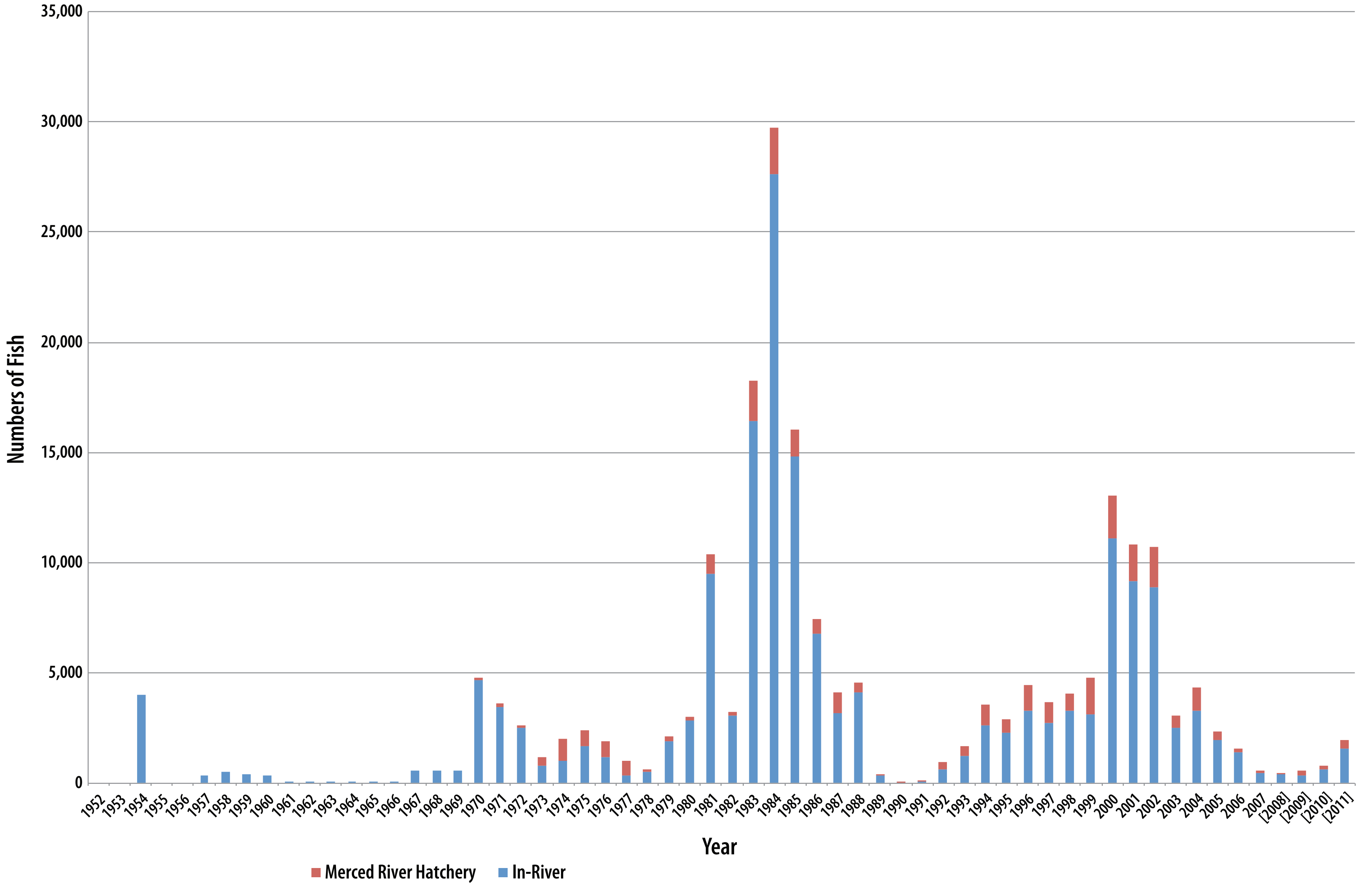
Habitat Alteration

Gold and aggregate mining have reduced spawning and rearing habitat for Chinook salmon and steelhead. Both gold and aggregate mining have removed gravel from the river, which is used as spawning substrate for adults (Stillwater Sciences 2002). From 1907–1952, the Lower Merced River channel and floodplain were dredged for gold. After extracting the gold, the tailings were placed in rows on the floodplain. The tailings prevent riparian vegetation from establishing and confine the river channel to a narrow corridor. Because of the dredging and the lack of sediment supply from upstream, the dredged reach is characterized by long, deep pools. Both Chinook salmon and steelhead need shallow, riffle habitat with gravel for successful spawning (Stillwater 2002). Aggregate mining, which began in the 1940s and continues today, excavates floodplain habitat important for rearing Chinook salmon and spawning Sacramento splittail.

Inundation of floodplains is also important for establishing and maintaining a healthy riparian vegetation community (Stillwater Sciences 2002). Aggregate mining also creates pits that provide habitat for largemouth bass, which prey on native fish, including outmigrating juvenile Chinook salmon. In-channel mining has been discontinued, but floodplain and terrace mining continues today (Stillwater 2002). Bank stabilization has been used throughout the Merced River to prevent bank erosion.

The riprap, concrete rubble, and gabions that have been used limit channel migration and native riparian vegetation establishment (Stillwater Sciences 2002). Channel migration is important to allow different instream habitat types to form (pools, riffles, runs), which support different life stages of salmon and other fish species. Riparian vegetation along the river banks provides food and cover and controls water temperatures for juvenile salmonids. Rock stabilization along the banks prevents riparian vegetation from establishing and is typically associated with nonnative, invasive plant species such as giant reed (*Arundo donax*) (Stillwater Sciences 2002).

Flood regulation, levee construction, and floodplain alteration have reduced the extent and frequency of floodplain inundation on the Merced River (Stillwater Sciences 2002). Losses and degradation of riparian and floodplain habitat and reductions in natural hydrologic variability that connect rivers to their floodplains has been identified as a major stressor on native Central Valley fish populations through direct impacts on spawning and rearing habitat availability and indirect impacts on aquatic productivity and food web support provided by seasonal floodplain inundation (see Appendix C, *Technical Report on the Scientific Basis for Alternatives San Joaquin River Flow and Southern Delta Salinity Objectives*). Although specific food web studies have not been conducted in the Merced River, current research indicates that regulated flows downstream of dams and losses of overbank flooding have likely contributed to historical declines and current limitations on native fish populations through reductions in primary and secondary production (phytoplankton and



Source: CDFG, GrandTab

Note: 2008-2011 data are preliminary

Graphics...00427.11 (07-27-2015)

Figure 7-3
Estimates of Annual Escapement of Fall-run Chinook Salmon in the Merced River from 1952 to 2011

invertebrate production) associated with seasonal floodplain inundation (Sommer et al. 2004; Ahearn et al. 2006).

Water Quality

As discussed for the Stanislaus and Tuolumne Rivers, pollutants from agriculture and increasing urbanization have been identified as potential stressors on steelhead and other aquatic resources in the Merced River. Unsuitable water temperatures for Chinook salmon and Central Valley steelhead have been identified in the Merced River. Elevated water temperatures have been recorded in the lower reach, some portions of the spawning reach, and at the Merced River Hatchery in October and November. In late April and May, water temperatures exceed limits for emigrating smolts. Elevated spring water temperatures are more prevalent on the Merced River than in the Stanislaus or Tuolumne Rivers due to the Merced River's southerly location and higher air temperatures (Stillwater Sciences 2002).

Introduced Species and Predation

Predation is a possible source limiting survival of juvenile Chinook salmon in the Merced River. As discussed previously, some hot-spots exists, such as in-river mining pits provide habitat for largemouth bass and other nonnative predatory fish species (Grossman et al. 2013).

Hatchery Operations

The Merced River has one hatchery, the Merced River Hatchery, located below the Crocker-Huffman Dam. It is the only hatchery in the SJR Basin (Stillwater Sciences 2002). In recent years, the percentage of hatchery-reared fall-run Chinook salmon returning to the LSJR and the three eastside tributaries has been high (Greene 2009) even though hatchery fish are typically less productive and have higher straying rates than wild fish. A study by Mesick (2009) found that up to 58 percent of Merced River Hatchery fall-run Chinook salmon strayed to the Sacramento River Basin when flows in the SJR were less than 3,500 cfs for 10 days in late October, but stray rates were less than 6 percent when flows were at least 3,500 cfs (CSPA and CWIN 2010; Mesick 2010b). This report indicated that providing 1,200 cfs flows from the three eastside tributaries to the LSJR for 10 days in late October increases escapement by an average of 10 percent (CSPA and CWIN 2010).

The average estimated returns of hatchery Chinook salmon to the Merced River from 1998–2007 was 72.8 percent. Because of the high numbers of hatchery fish returning to the Merced River and the low numbers of salmon returning every year, this creates a high risk of extinction for the Merced River fall-run population (Mesick 2010a). Hatchery production has been shown to negatively affect the genetic diversity and fitness of wild salmonid populations. Impacts can be genetic, ecological, or behavioral. Fish produced in the Merced River Hatchery can displace wild salmonid juveniles through competition and predation, competition with wild adults for limited resources, and introgression with other runs of Chinook salmon outside of the SJR Basin (Moyle 2002). However, a large portion of the existing genetic diversity for Central Valley Chinook salmon are contained in hatchery origin stocks, so hatchery stocks may be important contributors to overall stock recovery, including natural and hatchery origin fish.

Disease

Between 2000 and 2002, BKD was been detected in both natural and hatchery fall-run Chinook salmon juveniles in the Merced River (Nichols and Foott 2002). Occurrence of the parasite that causes BKD in samples of fish kidneys generally increased from 2 percent of the juvenile samples in 2000 to 90–100 percent of the 2001 samples. It then decreased to only 51 percent of the 2002 samples. Heavy infections were observed in 22 percent of the samples in 2002 (Nichols and Foott 2002). Proliferative Kidney Disease (PKD), caused by the myxosporean *Tetracapsuloides bryosalmonae*, has been diagnosed in Merced River Hatchery juvenile Chinook salmon for several decades, and is a currently considered a significant mortality factor for hatchery smolts during their early seaward entry phase (Foott et al. 2007).

LSJR

The LSJR between the Merced River and the Delta historically supported a distinctive native fish fauna adapted to widely fluctuating riverine conditions ranging from large winter and spring floods to low summer flows. Prior to large-scale hydrologic and physical alteration of the SJR, the fish community in this reach was dominated by fishes adapted to warmwater habitats of the valley floor, including deep, slow river channels, oxbow and floodplain lakes, swamps, and sloughs. These fishes included Sacramento perch, thicktail chub, tule perch, hitch, Sacramento blackfish (*Orthodon microlepidotus*), Sacramento splittail, Sacramento pikeminnow, and suckers. Anadromous species, including spring-run Chinook salmon, fall-run Chinook salmon, and sturgeon occurred seasonally in these reaches during their upstream and downstream migrations. Key habitats that contributed substantially to the productivity of native fishes on the valley floor were the floodplains, riparian forests, and wetlands that were inundated by winter and spring floods (Moyle 2002).

Currently, the SJR from the Merced River to the Delta provides migration habitat for fall-run Chinook salmon and steelhead as they migrate upstream to spawning tributaries and downstream toward the Delta. The seasonal timing of adults and juveniles in this reach generally corresponds to that described for each of the tributaries. Other native species that occur in this reach include Sacramento sucker, Sacramento pikeminnow, Sacramento splittail, tule perch, prickly sculpin (*Cottus asper*), Sacramento blackfish, and hardhead (Brown and May 2006).

Many of the species that were present historically in the LSJR have been replaced by nonnative fish species that are better adapted to the disturbed habitat conditions (Moyle 2002). Most notably, the deep-bodied fish assemblage of the valley floor and lower portions of the three eastside tributaries has been largely replaced by largemouth bass, sunfish species, and other nonnative warmwater species that likely prey on or compete with the native species (Moyle 2002). Nonnative fishes reported to occur in the LSJR include red shiner (*Cyprinella lutrensis*), inland silverside (*Menidia beryllina*), threadfin shad, western mosquito fish (*Gambusia affinis*), fathead minnow (*Pimephales promelas*), largemouth bass, bigscale logperch (*Percina macrolepida*), bluegill, white crappie (*Promoxis annularis*), striped bass, redear sunfish (*Lepomis microlophus*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), black bullhead (*Ameiurus melas*), channel catfish, and green sunfish (Brown and May 2006).

Environmental Stressors

Baseline stressors that affect aquatic resources in the LSJR include alteration of the natural flow regime, loss of natural riverine function and morphology due to habitat modification and flood control activities, predation, water quality (e.g., temperature and pollutants), and disease.

Flow Regulation

The natural hydrologic regime and geomorphic processes of the LSJR have been substantially altered by upstream dams, diversions, and agricultural drainage. Analyses of the historical relationship between spring flows during the juvenile Chinook salmon emigration period and subsequent adult abundance indicate that flow in the three eastside tributaries and LSJR has a substantial influence on juvenile salmon survival between March and June as they complete their freshwater rearing, smoltification, and migration stages. Flow in the three eastside tributaries and LSJR may affect survival through a number of mechanisms, including effects on water temperature, predation, habitat availability (e.g., access to floodplain habitat), water quality (e.g., contaminants), and entrainment in diversions (see Appendix C, Chapter 3, *Scientific Basis for Developing Alternate San Joaquin River Flow Objectives*).

Habitat Alteration

Clearing of land for agriculture and flood control activities have resulted in loss or disconnection of the river from historical wetland, riparian, and floodplain areas (Brown 2000). The loss of habitat connectivity between the river and riparian areas in the LSJR has greatly affected salmonids (McBain and Trush 2002). Riparian forests that historically surrounded river and estuarine channels had an important role in minimizing stressors related to habitat availability, water temperature, and water quality. However, riparian forests have generally been converted to agricultural uses, reducing the amount of floodplains and other habitat and increasing surface water temperatures.

Flood control levees closely border much of the river but are set back in places, creating some off-channel aquatic habitat areas when inundated. However, the levees and dikes have acted to isolate historical riparian land and floodplains from the channel. The bank protection along channel margins, coupled with a reduced flow regime, has stabilized the channel, reducing bank erosion, lateral migration, and greatly reducing the processes that create complex side channels and high flow scour channels (McBain and Trush 2002). This has led to a reduction of various types of habitat (e.g., refuge, rearing, and spawning) for steelhead, Chinook salmon, and other native fish species.

Flood regulation, channel confinement, and disconnection of historical wetland, riparian, and floodplain habitat have greatly decreased the frequency and extent of floodplain inundation and the quantity and quality of existing habitat for juvenile salmonids and other native fishes in the LSJR (McBain and Trush 2002). Losses and degradation of riparian and floodplain habitat and reductions in natural hydrologic variability that connect rivers to their floodplains has been identified as major stressors on native Central Valley fish populations. These factors directly impact spawning and rearing habitat availability and indirectly impact aquatic productivity and food web support provided by seasonal floodplain inundation (see Appendix C, *Technical Report on the Scientific Basis for Alternatives San Joaquin River Flow and Southern Delta Salinity Objectives*). Recent modeling of the potential ecological benefits associated with floodplain restoration in the LSJR and southern Delta indicates that the frequency and duration of floodplain inundation events sufficient to meet the habitat requirements of Chinook salmon, Sacramento splittail, and their food resources (phytoplankton and zooplankton), are limited under current and potential future hydrological conditions (Matella and Merenlender 2014). However, the frequency and duration of floodplain inundation events can be increased through floodplain restoration and the restoration of a more natural flow regime to achieve the desired levels of hydrologic connectivity (Matella and Merenlender 2014).

Water Quality

Water temperatures in the LSJR reflect those of the three eastside tributaries and are generally within a range considered to be suitable (< 68°F) for rearing and outmigrating Chinook salmon smolts during April and May (SJRGA 2011). However, in certain water year types, elevated water temperature can be a major stressor on fish, especially salmonids, during months when juveniles are rearing and outmigrating. All of the tributaries generally experience an increase in water temperatures in the late spring and summer, which then contributes to increases in water temperature in the LSJR. Summer water temperatures in many Central Valley streams regularly exceed 77°F (Moyle 2002). These sustained periods of increased water temperature are known to affect behavioral and biological functions of all fishes in the LSJR, notably salmonids and Central Valley steelhead.

The LSJR is generally considered to have poor water quality in part due to agricultural drainage, which is a major source of salts and pollutants (e.g., boron, selenium, pesticides). Discharges from the existing wastewater treatment plants (WWTP) also reduce water quality in the LSJR (State Water Board 2006). However, water quality is known to improve during periods of high flow due to dilution effects.

Introduced Species and Predation

Nonnative fish species prey on Central Valley steelhead and fall-run Chinook salmon in the LSJR. The most prevalent nonnative predators in the LSJR are: striped bass (Moyle 2002); smallmouth bass; and largemouth bass. Although bass are only one of the introduced species that prey on salmonids, they probably represent the most change in predation experienced compared to historical conditions (USDOI 2008), in part due to their salt tolerance to polluted agricultural runoff especially during spawning (Moyle 2002).

Disease

Diseases have been identified in LSJR fish populations. Samples from Chinook salmon juveniles caught with a Kodiak trawl at Mossdale were positive for the causative agent of BKD (Nichols and Foott 2002). Additionally, BKD was detected in both natural and hatchery juveniles from the LSJR in both 2000 and 2001 *Ceratomyxa shasta*, a myxosporean parasite, is also a pathogen present in the Central Valley, and they are of particular concern on the LSJR (Nichols and Foott 2002).

7.2.3 Extended Plan Area

The native fish communities of the extended plan area have changed substantially beginning with gold rush immigration and subsequent landscape modification (Moyle et al. 1996). Native fishes include rainbow trout *(Oncorhynchus mykiss)*, Sacramento hitch *(Lavinia exilicauda exilicauda)*, and hardhead minnow *(Mylopharodon conocephalus)* (Moyle et al.1996). Many nonnative fish were introduced to the rivers, as well as upper watershed lakes, that had previously been fishless (Moyle et al. 1996). These species include brown trout *(Salmo trutta)* and eastern brook trout *(Salvelinus fontinalis)* (Moyle et al. 1996). The rim dams blocked upstream migration of anadromous species. The recreational fishery in the rivers and reservoirs in the extended plan area includes rainbow trout, eastern brook trout, and brown trout, including some hatchery-stocked species (Moyle et a Central California roach 1996; National Wild and Scenic River Systems 2016). There are no federal or state endangered or threatened fish species associated with the reservoirs in the extended plan area (i.e., above the rim dams) (CDFW 2016b). There are four fish species of special concern (CSC) associated with these reservoirs: hardhead minnow; Central California roach *(Lavinia symmetricus symmetricus)*; Sacramento hitch; and riffle sculpin *(Cottus gulosus)* (CDFW 2016b).

7.2.4 Southern Delta

The southern Delta is part of the larger Bay-Delta system and provides habitat for resident and migratory fish species. Essential habitats for salmonids and other fish species consist of suitable water quality and water quantity conditions. For salmonids, these conditions must support juvenile and adult physiological transitions between fresh water and saltwater (NMFS 2009b). Changes to estuarine habitat that degrade any of these conditions can have a negative effect on aquatic resources. Therefore, similar stressors influence the abundance and presence of fish in the southern Delta and Bay-Delta as described above for the three eastside tributaries and LSJR. However, conditions in the southern Delta are also influenced by river inflow, tidal action, water export facilities and local pump diversions, and agricultural and municipal return flows (Moyle 2002).

Environmental Stressors

The distribution of fish in the southern Delta is determined by tidal flows, tidally averaged (nontidal) net flows, and directed swimming of the fish. The largest flows in the southern Delta are tidal flows, which far exceed other flows in most Delta channels. The tidal flows tend to move small, weak-swimming fish, such as fish larvae, upstream and downstream, dispersing them into neighboring channels without imparting any net directional movement (Kimmerer and Nobriga 2008). Nontidal flows determine the net direction of water movement (i.e., net flows) and of fish larvae and other weak swimmers suspended in the water (Kimmerer 2008; Kimmerer and Nobriga 2008; Monsen et al. 2007). Baseline stressors that affect aquatic resources in the southern Delta include alteration of the natural Delta inflows and hydrodynamics, habitat alteration due to channelization, diversions and entrainment, water quality (e.g., temperature and pollutants) and predation.

Delta Inflows and Hydrodynamics

Recent fisheries investigations in the southern Delta (e.g., Vernalis Adaptive Management Program [VAMP]) have focused on the survival of Chinook salmon smolts in relation to SJR inflows, Delta exports, and barrier installation at the head of Old River (HORB). A review of the VAMP studies and other investigations and their findings is presented in Appendix C, Chapter 3, *Scientific Basis for Developing Alternate San Joaquin River Flow Objectives.*

Changes in delta smelt habitat quality in the San Francisco estuary can be indexed by changes in X2. The abundance of many local species has tended to increase in years when flows into the estuary are high and the 2 ppt isohaline is pushed seaward (Jassby et al. 1995), implying that over the range of historical experience, the quantity or suitability of estuarine habitat increases when outflows are high (USBR 2008). Because large volumes of water are drawn from the estuary, water exports and inadvertent fish entrainment at the CVP and SWP export facilities are among the best studied top-down effects in the San Francisco estuary (Sommer et al. 2007). The export facilities are known to entrain most species of fish inhabiting the Delta (Brown et al. 1996) and are of particular concern in dry years, when the distributions of delta smelt and longfin smelt shift upstream, closer to the diversions (Stevens et al. 1985; Sommer et al. 1997).

Habitat Alteration

Prior to development and channelization, the Bay-Delta provided hospitable habitat for rearing and migrating salmonids. Historical floodplain areas were dynamic areas that generally contained complex, heterogeneous habitat types (e.g., grassland, riparian, tidal and nontidal marsh, and agriculture). Inundation of surrounding floodplains provided refuge, warmer temperatures, and abundant food supplies for rearing juvenile Chinook salmon, enabling them to grow faster than by solely migrating through riverine and southern Delta corridors. These smolts grew quickly and migrated out to the ocean sooner, ultimately resulting in higher survival rates in the ocean (Stillwater Sciences 2003).

Currently, the LSJR flow into the southern Delta is influenced by existing channels. From Vernalis, the Old River channel diverges from the LSJR downstream of Mossdale and connects with Middle River and Grant Line Canal. About 50 percent of the LSJR flow splits into the Old River channel, and the other 50 percent continues down the LSJR channel toward Stockton. Channel pathways affect migration of juvenile Chinook salmon. Temporary barriers or agricultural barriers in the Middle River, Grant Line Canal, and Old River can block access, restrict passage to rearing habitat, or redirect migration for adult and juvenile fall-run Chinook salmon. Specifically, the HORB has been installed in April and May of many years (not in years with flows above 7,000 cfs) to improve juvenile Chinook fish migration from the SJR Basin.

The current channelization and other southern Delta developments make the Bay-Delta less hospitable for Chinook salmon as compared to the historical Bay-Delta conditions. Central Valley salmonids and other native fishes use tidal marsh directly or indirectly for at least one if not several of their life stages. Tidal marsh provides spawning and rearing areas for Sacramento splittail and rearing habitat for salmonids. However, much of the historical riparian forests that support suitable habitat for these species has been converted to agricultural uses (Moyle 2002). This conversion has reduced the amount of floodplains and habitat and increased surface water temperatures.

Diversions and Entrainment

The two major water diversions in the southern Delta are the SWP (Banks Pumping Plant) and the CVP (Jones Pumping Plant). The Contra Costa Water District also diverts water from the southern Delta. Many small agricultural diversions (siphons and pumps) divert water from throughout the Delta during the spring and summer irrigation season. These diversions affect fish species by physically entraining them and altering flow such that migration cues are modified.

CVP and SWP export pumping is controlled under the 2006 Bay-Delta Plan objectives (State Water Board's Water Right Decision 1641 [D-1641]). Both the CVP and the SWP have maximum permitted pumping (or diversion) rates. Delta outflow requirements may limit pumping if the combined Delta inflow is not enough to satisfy the in-Delta agricultural diversions and the full capacity CVP and SWP pumping. When pumping is limited, the cooperative operating agreement (COA) governs the CVP and SWP share in reservoir releases and Delta pumping. The CVP and SWP typically increase their rate of pumping approximately 10–40 percent during April and May.

Changes in the direction of channel flows, due to export pumping at the CVP and SWP pumping plants, strongly affect net flow patterns in the southern Delta. These altered flow patterns also influence how fish are distributed in the southern and interior Delta and how long the fish remain there (NMFS 2009a; Kimmerer and Nobriga 2008; Monsen et al. 2007). These flows can lead to increased straying away from the main channel of the SJR and towards the southern Delta via reverse OMR flows (USDOI 2008; Kimmerer and Nobriga 2008; Mesick 2001). Reverse OMR flows occur because the major freshwater source, the Sacramento River, enters on the northern side of the Bay-Delta while the two major pumping facilities, the CVP and SWP, are located in the south. This results in a net water movement across the Delta in a north to south direction along a network of channels, including OMR (see Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*).

Water is drawn from the central Delta through lower OMR to the pumps in the southern Delta when combined pumping exceeds the incoming flow from the LSJR. This situation causes reverse flows in OMR. Reverse flows in the southern Delta make fish more vulnerable to entrainment at the pumps and delay migrations through or from the southern Delta. However, SJR inflow generally counteracts the effects of reverse OMR flows by providing higher inflows, which tend to result in movement of fish and larvae away from the southern Delta. In addition to the pumps, there are hundreds of agricultural diversions throughout the southern Delta that entrain small fish. These diversions not only entrain fish, but also affect them indirectly by altering flow patterns, food supply, and habitat.

The CVP and SWP pumping facilities are known to entrain various fish species in the southern Delta nearly year-round. The CVP and SWP fish facilities report entrainment of adult delta smelt during spawning migration December–April (USFWS 2008) while juveniles are entrained primarily April–June. Longfin smelt are primarily observed in the salvage operations during the spring (March–May) as juveniles, although larger subadult longfin smelt are also observed in the salvage operations during early winter. Young-of-year splittail are entrained April–August when fish are moving downstream into the Bay-Delta (Meng and Moyle 1995). Juvenile Chinook salmon are entrained in all months but primarily November–June when juveniles are migrating downstream. Green sturgeon are rarely entrained at the CVP and SWP fish facilities (probably due to low abundance in the southern Delta); however, entrainment has occurred in every month, indicating the presence of green sturgeon year-round (USBR 2009). Juvenile Central Valley steelhead from the SJR Basin are vulnerable to entrainment and salvage operations at the CVP and SWP export facilities, primarily March–May (Kimmerer 2008).

Pumping in the southern Delta may disorient salmonids and cause delayed outmigration of salmonids. While recent studies (Newman and Brandes 2010) indicate that spring water exports are not significantly impacting SJR outmigrating smolts under certain export conditions, there could be significant impacts on salmonids if exports are outside of the range tested. For example, in addition to creating false migration pathway, as discussed previously, strong negative flows in OMR can confuse outmigrating and rearing salmonids. Pumping-related impacts could affect salmonids between March and June but could vary with water year type. When exports are high relative to SJR flows, it is likely that little, if any, SJR Basin water reaches the San Francisco Bay. It is necessary for the scent of the SJR Basin to enter the bay in order for adult salmonids to find their way back to their natal streams. Specifically, Mesick (2001) observed that reduction, or even the elimination, of this scent trail is likely to increase the likelihood for fall-run Chinook salmon to stray from the SJR Basin and into the adjacent Mokelumne River or Sacramento River Basins.

There are over 2,200 small water diversions within the Delta, the majority of which are unscreened (Herren and Kawasaki 2001). These unscreened diversions have the potential to directly remove fish from the channels and alter local movement patterns (Kimmerer and Nobriga 2008; CDFG 2011a). Removal of fish and alteration of movement patterns take place throughout the year and are highest during fall, winter, and spring (CDFG 2011a). April–September is the high irrigation season and diversion period. Agricultural diversions have the limited potential to remove spring-run and winter-run Chinook salmon adults, juveniles, or fry, or any life stage of Central Valley steelhead from the Bay-Delta. It is undocumented how many juvenile Central Valley steelhead are entrained at the unscreened small water diversions in the Bay-Delta. However, because Central Valley steelhead are moderately large (more than 200 mm fork length), typically older, and relatively strong swimmers when outmigrating, the effects of small in-Delta agricultural water diversions on steelhead are thought to be lower than those on Central Valley Chinook salmon. Longfin smelt and delta smelt are typically present in the Delta primarily November–June. Since exports are typically greater when inflows from the Sacramento River and LSJR are greater in spring and summer, longfin smelt and delta smelt are expected to be affected by diversions.

Other smaller diversions, such as drawing cooling water for power generation plants and small agricultural diversions, also affect migrating Chinook salmon, but not to the extent of the CVP and SWP pumping facilities. Drawing cooling water from the Bay-Delta through power generation plants can remove fish and kill them due to mechanical and thermal trauma. These effects are potentially greatest on pelagic larvae of longfin smelt and delta smelt, one or both of which could be adjacent to the power plants in the western Delta during late December through July. Fall-run Chinook salmon fry may also be present and somewhat vulnerable late December through February during high-outflow years. Juvenile and adult smelt are present also during all other times of year but are less vulnerable because of greater mobility. The western Delta power plants are called to operate during times of high power demand, which are most apt to occur during peak summer temperatures July–September.

Water Quality

Because the southern Delta receives a substantial portion of its water from the LSJR, the influence of the relatively poor LSJR water quality is greatest in the southern Delta channels. Currently, the LSJR, Delta, and San Francisco Bay are listed under Section 303(d) of the federal Clean Water Act (CWA) as impaired for a variety of toxic contaminants that may contribute to reduced population abundance of important fishes and invertebrates.

Agricultural and urban runoff and domestic WWTP discharges in the southern Delta can cause direct and chronic toxicity to eggs, larvae, and adults of pelagic fish species. Some other contaminants that can affect pelagic fishes (delta smelt and longfin smelt) in the southern Delta are mercury, copper, oil and grease, selenium, pesticides, herbicides, and ammonia. These contaminants have the potential to affect fish or the food webs that support them and typically result from in-river activities (mining and dredging), urban runoff, urban sewage, municipal and industrial discharges, and agricultural drain water.

In addition, turbidity in the southern Delta is low, which may reduce habitat for delta smelt and other species (Feyrer 2004; Feyrer and Healey 2003; Feyrer et al. 2007; Monsen et al. 2007; Nobriga et al. 2008). Therefore, flow patterns that cause delta smelt to move into the southern Delta could negatively affect the population. During the fall adult salmon migration season, when LSJR inflows to the Bay-Delta are less than 1,500 cfs, low DO levels in the SJR at the Stockton Deep Water Ship Channel (e.g., less than 6 ppm) create a chemical migration barrier to upstream migrating adult salmon. Failure of SJR Basin salmon to reach the spawning grounds results in negative spawning impacts on the SJR fall-run Chinook salmon population (CDFG 2011a).

Unsuitable salinity gradients can cause physiological stress for many aquatic species in the Bay-Delta. Inflow from the LSJR to the Bay-Delta helps to establish the location in the Bay-Delta of the low salinity zone (LSZ), an area often referenced by X2 that historically has had high prey densities and other favorable habitat conditions for rearing juvenile delta smelt, striped bass, and other fish species (USBR 2008). However, changes in Delta inflows from the LSJR have the potential to alter LSZ salinity gradients and the location of X2, which can influence temperature, turbidity, and other habitat characteristics (Moyle et al. 2010). These alterations can potentially create an environment that is physiologically stressful to most organisms that utilize the Bay-Delta and X2, including Chinook salmon and Central Valley steelhead.

Agricultural diversions also influence the typical salinity gradients that migrating smolts encounter. Typically, outmigrating smolts would perceive a steadily increasing salinity gradient as the ocean grew closer. However, today, outmigrating fall-run Chinook salmon smolts encounter agricultural return flows that are of elevated temperature, nutrient and pesticide load, and salinity concentration (State Water Board 1999) in the Bay-Delta. As juveniles enter the southern Delta, the salinity (or electrical conductivity [EC][13]) at the three southern Delta compliance stations downstream of Vernalis (SJR at Brandt Bridge [P-12], Old River at Middle River [C-8], and Old River at Tracy Boulevard [C-6]) is generally slightly higher than the Vernalis EC. This is largely due to agricultural drainage and municipal discharges. As juveniles orient themselves and begin the last leg of their outmigration, they encounter a plume of low salinity Sacramento River water from the Delta Cross Channel, which is shuttled across the interior Bay-Delta.

Water temperature is determined by a number of factors, such as quantity and quality of water, channel geometry, and ambient air temperatures (TBI 2010). In general, the special-status fish species listed in Table 7-2 require lower water temperatures than the recreationally important fish species listed in Table 7-3. Water temperatures in the southern Delta show temperatures generally increase as a function of distance downstream within the mainstem of the LSJR (SJRGA 2010). Sites sampled on the mainstem of the LSJR as it enters the southern Delta (e.g., Durham Ferry, Mossdale, and Old River at HORB) were within a range considered to be suitable during April and May (typically < 68°F) for emigrating juvenile Chinook salmon (SJRGA 2010). Temperatures are slightly higher, but generally under 68°F further downstream within the southern Delta (e.g., Old River-Indian Slough Confluence) during this time (SJRGA 2010). However, water temperatures during early June were within the range (> 68°F) considered to be stressful for juvenile Chinook salmon (SJRGA 2010). Lethal temperatures for Chinook salmon and Central Valley steelhead juveniles are not reached under baseline conditions at Vernalis until August, and at that time these fishes typically are not present in the Bay-Delta.

Introduced Species and Predation

Predation rates in the southern Delta are believed to be higher than in other parts of the Bay-Delta. This is due to a variety of reasons, including: (1) turbidity is generally lower in the southern Delta, which increases visibility for predators (Nobriga et al. 2008; Feyrer et al. 2007); (2) many of the structures and facilities in the southern Delta support excellent conditions for predators by providing suitable habitat and flows, especially the Clifton Court Forebay and fish louver screens at the CVP and SWP facilities; and (3) recent invasions by the submerged plant, Brazilian water weed *Egeria densa* (Nobriga et al. 2008; Feyrer et al. 2007). The Brazilian water weed is an invasive, nonnative freshwater species that grows in denser stands than native submerged aquatic

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[13] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

vegetation, providing rearing habitat for nonnative fish species, including bass. Brazillian water weed filters sediment and nutrients from the water column resulting in decreased turbidity in the southern Delta, which historically provided cover and habitat for outmigrating smolts but now provides cover for larger predatory fishes (Ferrari et al. 2013).

Based on their review of the VAMP studies, Dauble et al. (2010) concluded that predation appears to be having a variable effect on survival of smolts moving through the Delta (Grossman et al. 2013), which may in part account for the low survival of tagged fish in recent years as measured in the SJR at Vernalis (Dauble et al. 2010).

7.3 Regulatory Background

For a broad summary of relevant statutory and regulatory provisions, see Chapter 1, *Introduction*. For a more specific description of regulatory requirements set as existing and historical instream flow prescriptions on the LSJR and the three eastside tributaries, see Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*.

7.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to aquatic resources are described below.

Clean Water Act

The CWA generally applies to all navigable waters of the United States and is discussed in Chapter 5, *Surface Hydrology and Water Quality.*

Central Valley Project Improvement Act

The Central Valley Project Improvement Act (CVPIA) was enacted in 1992 to balance the needs of fish and wildlife resources with other uses of CVP water. The purposes of the CVPIA are as follows.

- Protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River Basins of California.
- Address impacts of the CVP on fish, wildlife, and associated habitats.
- Improve the operational flexibility of the CVP.
- Increase water-related benefits provided by CVP to the State of California through expanded use of voluntary water transfers and improved water conservation.
- Contribute to California's interim and long-term efforts to protect the Bay-Delta Estuary.
- Achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agricultural, municipal and industrial, and power contractors.

The CVPIA added mitigation, protection, and restoration of fish and wildlife to the purposes of the CVP, dedicated 800,000 AF of CVP yield for the primary purpose of implementing fish, wildlife, and habitat restoration, and created a Central Valley Project Restoration Fund to carry out CVPIA programs, projects, plans, and habitat restoration, improvement, and acquisition provisions. Among the CVPIA programs that benefit salmonids and other fish species is the AFRP, the Anadromous Fish

Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP conducts monitoring, education, and restoration projects directed toward recovery of anadromous fish species in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines federal funding with state and private funds to prioritize and construct fish screens on major water diversions mainly in the Upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI's ability to meet regulatory water quality requirements.

Endangered Species Act

The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. ESA is administered by USFWS and NMFS. In general, NMFS is responsible for protecting ESA-listed threatened or endangered marine species and anadromous fishes, while other listed species (e.g., freshwater and terrestrial species) are under USFWS jurisdiction. An *endangered species* is defined as "… any species which is in danger of extinction throughout all or a significant portion of its range." (16 U.S.C., § 1532, subd. (6).) A *threatened species* is defined as "… any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." (16 U.S.C., § 1532, subd. (20).) ESA Section 9 makes it illegal to *take* (i.e., harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in such conduct) any endangered fish or wildlife species. (16 U.S.C., §§ 1538; 1532, subd. (19).)
For threatened fish and wildlife species, ESA Section 4(d) allows for the adoption of protective regulations, including provisions extending the Section 9 take prohibition to that species. (16 U.S.C., § 1538, subd. (d).)

ESA also requires the designation of critical habitat for listed species. *Critical habitat* is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to a species' conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (NMFS 2011; NMFS 2009a; ICF International 2012).

If a federal agency believes that its action will jeopardize a listed species or destroy or adversely modify critical habitat, the agency must request formal consultation with USFWS or NMFS, as appropriate, under Section 7 of the ESA. (16 U.S.C., § 1536.) The USFWS or NMFS then issues a BO as to whether the action is likely to jeopardize a listed species or to destroy or adversely modify its critical habitat. If an action will result in jeopardy, the USFWS or NMFS will provide the consulting federal agency with reasonable and prudent alternative actions to avoid jeopardy. For any non-federal action otherwise prohibited by Section 9, the applicant must apply to the Secretaries for an incidental take permit under ESA Section 10 (16 U.S.C., § 1539.) Species that are candidates for listing are not protected under ESA; however, USFWS advises that a candidate species could be elevated to listed status at any time, and, therefore applicants should regard these species with special consideration.

Long-Term Central Valley Project Operations Criteria and Plan and Biological Opinions

The *Long-Term Central Valley Project – Operations Criteria and Plan* (OCAP) is a baseline description of the facilities and operating environment of the CVP and SWP and identifies the many factors influencing the physical and institutional conditions and decision-making processes under which the USBR and the California Department of Water Resources (DWR) operate the integrated SWP and CVP system, including how the CVP and the SWP divert, store, and convey water consistent with applicable law (USBR 2008).

U.S. Fish and Wildlife Service Biological Opinion

Pursuant to the ESA, USBR requested a biological opinion from the USFWS as to whether its operations, as described in the OCAP, would jeopardize listed species. The 2008 USFWS BO concurred with USBR's determination that the coordinated operations of the SWP and CVP are not likely to adversely affect listed species, with the exception of delta smelt (USFWS 2008). The USFWS concluded that the coordinated operations of the SWP and CVP, as proposed, were likely to jeopardize the continued existence of delta smelt and adversely modify delta smelt critical habitat. Consequently, USFWS developed a reasonable and prudent alternative (RPA) to the project as described in the OCAP, consisting of a number of operational changes and other actions to avoid the likelihood of jeopardizing the continued existence of delta smelt or destroying or adversely modifying delta smelt critical habitat. These actions include: (1) preventing/reducing entrainment of delta smelt at the Jones and Banks Pumping Plants, (2) providing adequate habitat conditions that will allow adult delta smelt to successfully migrate and spawn in the Bay-Delta, (3) providing adequate habitat conditions that will allow larvae and juvenile delta smelt to rear, and (4) providing suitable habitat conditions that will allow successful recruitment of juvenile delta smelt to adulthood. In addition, USFWS specified that it is essential to monitor delta smelt abundance and distribution through continued sampling programs through the Interagency Ecological Program (IEP). The RPA restricted pump operations and limited deliveries of water to SWP and CVP contractors south of the Delta.

Various parties, including SWP and CVP contractors, brought suit in federal court challenging the USFWS 2008 BO. Years of litigation followed, and in March 2014, the United States Court of Appeals, Ninth Circuit, upheld the biological opinion and concluded that USBR must comply with the National Environmental Policy Act to evaluate the effects of the USBR's adoption and implementation of the 2008 BO.

National Marine Fisheries Service Biological Opinion

The NMFS BO (NMFS 2009a) concluded that the joint operations of the CVP and SWP, as described in the OCAP, were likely to jeopardize the continued existence of the following species.

- Sacramento River winter-run Chinook salmon.
- Central Valley spring-run Chinook salmon.
- Central Valley steelhead.
- Southern DPS of North American green sturgeon.
- Southern resident killer whale.

NMFS (2009a) also concluded that CVP and SWP operations, as described in the OCAP, were likely to destroy or adversely modify the designated critical habitats of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and green sturgeon. The actions included in the RPA to USBR's proposed action are summarized below relevant to the plan area (NMFS 2009a).

- New OMR reverse flow levels to limit the strength of reverse flows and reduce entrainment at the SWP and CVP facilities.
- Additional technological measures at the SWP and CVP facilities to enhance screening and increase survival of fish.
- Additional measures to improve survival of steelhead smolts, including increased SJR flows and export curtailments, and a new study of acoustic tagged fish in the SJR Basin to evaluate and refine these measures.
- A year-round minimum flow regime on the Stanislaus River necessary to minimize project effects on each life stage of steelhead, including new springtime flows that will support rearing habitat formation and inundation, and create pulses that allow salmon to outmigrate successfully.

Various parties challenged the 2009 BO in federal court. In December 2014, the United States Court of Appeals, Ninth Circuit, upheld the BO in its entirety.

Recovery Plan for Sacramento–San Joaquin Delta Native Fish Species

The *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* was released in 1996 by USFWS with the basic goal of establishing self-sustaining populations of species of concern. The plan specifically focused on delta smelt, longfin smelt, Sacramento splittail, and Sacramento perch.

National Wildlife Refuge System Improvement Act of 1997

Comprehensive conservation plans (CCPs) are prepared by USFWS and are required under the National Wildlife Refuge System Improvement Act of 1997. In 2006 the USFWS prepared a final CCP for the San Joaquin River National Wildlife Refuge to guide the management of the refuge for the next 15 years. The primary goals of the refuge are to accomplish the following: conserve and protect the natural diversity of migratory birds, resident wildlife, fish, and plants through restoration and management of riparian, upland, and wetland habitats on refuge lands; contribute to the recovery of threatened and endangered species, as well as the protection of populations of special-status wildlife and plant species and their habitats; provide optimum wintering habitat for Aleutian Canada geese to ensure the continued recovery from threatened and endangered species status; coordinate the natural resource management of the San Joaquin River National Wildlife Refuge in the context of the larger Central Valley-San Francisco ecoregion; and provide the public with opportunities for compatible, wildlife-dependent visitor services to enhance understanding, appreciation, and enjoyment of natural resources at the San Joaquin River National Wildlife Refuge (USBR 2011).

Federal Power Act

Under the Federal Power Act (FPA), the FERC is responsible for determining under what conditions to issue licenses, or relicense, non-federal hydroelectric projects. Under the provisions of Section 10(j) of the FPA, each hydroelectric license issued by FERC is required to include conditions for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. These required conditions are to be based on recommendations of federal and state fish and wildlife agencies. FERC may reject or alter the recommendations on several grounds, including if FERC determines they are inconsistent with the purposes and requirements of the FPA or other applicable law. The State Water Board exercises authority over hydropower projects through Section 401 of the Clean Water Act, which requires an applicant for a federal license or permit that conducts an activity that results in a discharge into the navigable waters of the United States to apply for a certification from the state that the discharge will comply with state and federal water quality standards. The certification will include conditions requiring compliance with the Bay-Delta Plan's water quality objectives, including the LSJR flow requirements. FERC does not have authority to review or set aside the water quality certification.

7.3.2 State

Relevant state programs, policies, plans, or regulations related to aquatic resources are described below. Descriptions of the *2006 San Francisco Bay/Sacramento-San Joaquin Delta Estuary Water Quality Control Plan* (Bay-Delta Plan), Porter-Cologne Act, California's water rights system, and State Water Board authorities are described in Chapter 1, *Introduction*.

California Endangered Species Act of 1970

CESA (Fish & G. Code, § 2050 et seq.), expresses state policy to conserve, protect, restore, and enhance any endangered or threatened species or its habitat. The Act generally prohibits the take (hunt, pursue, catch, capture, or kill) of listed species, although it may allow for take incidental to otherwise lawful activities. (Fish & G. Code, § 2080 et seq.) Under CESA, the California Fish and Game Commission has the responsibility for maintaining a list of threatened and endangered species (Fish & G. Code, § 2070), and CDFW may authorize take that is otherwise prohibited (by permits, agreements, etc.) or pursue enforcement actions for unauthorized take.

California Department of Fish and Wildlife Species Designations

CDFW maintains an informal list of "species of special concern." The intent of the designation is to focus on plant and wildlife species that are at conservation risk, stimulate research on poorly known species, and achieve conservation and recovery of species before they are listed under CESA. Species of special concern have factors in common such as small isolated populations, marked population decline, fragmented habitat, and association with habitats that are declining in California.

Salmon, Central Valley Steelhead Trout, and Anadromous Fisheries Program Act

The 1988 Salmon, Central Valley Steelhead Trout, and Anadromous Fisheries Program Act was enacted in response to reports that the natural production of salmon and steelhead in California had declined dramatically since the 1940s. The Act expressed the State's policy to significantly increase the natural production of salmon and steelhead trout by the end of the century. CDFW was charged with developing a plan and program that strives to double the then-current natural production of the fishery. (Fish & Game Code, § 6902, subd. (c).)

7.3.3 Regional or Local

Relevant regional or local programs, policies, plans, or regulations related to aquatic resources are described below. Although local policies, plans, and regulations are not binding on the State of California, below is a description of relevant ones.

County General Plans

As required by state law, counties must develop their own general plans. Within the plan area, applicable general plans include the *Calaveras County General Plan* (1996), the *Tuolumne County General Plan* (1996), the *Mariposa County Wide General Plan* (2010), and the *San Joaquin County Wide General Plan* (2005). These plans have policies that can preserve and protect open space and natural resources, such as rivers and reservoirs and the lands adjacent to them.

San Joaquin County Multi-Species Habitat Conservation and Open Space Plan

The *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan*, approved and adopted in November 2000, includes compensation measures to offset the effects of development on special-status plant, fish, and wildlife species throughout San Joaquin County, including the LSJR. The plan's purpose is to provide a strategy for balancing the need to conserve open space and the need to convert open space to non-open space uses while protecting the region's agricultural economy and preserving landowner property rights. The plan also is to provide for the long-term management of plant, fish, and wildlife species, especially those that are currently listed or may be listed in the future under ESA or CESA (County of San Joaquin 2012).

7.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on aquatic resources. It further describes the methods of analysis used to evaluate the potential impacts and to determine the significance of those impacts. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion if any significant impacts are identified.

7.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The thresholds derived from the checklist(s) have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Impacts on aquatic biological resources were identified as potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis as to whether the alternatives could result in the following.

- Cause significant changes in spawning success and habitat availability for warmwater species resulting from changes in reservoir water levels.
- Cause significant changes in availability of coldwater species reservoir habitat resulting from changes in reservoir storage.
- Cause significant changes in quantity/quality of physical habitat for spawning and rearing resulting from changes in flow.
- Cause significant changes in exposure of fish to suboptimal water temperatures resulting from changes in reservoir storage and releases.
- Cause significant changes in exposure to pollutants resulting from changes in flow.
- Cause significant changes in exposure to suspended sediment and turbidity resulting from changes in flow.
- Cause significant changes in redd dewatering resulting from flow fluctuations.
- Cause significant changes in spawning and rearing habitat quality resulting from changes in peak flows.
- Cause significant changes in food availability resulting from changes in flow and floodplain inundation.
- Cause significant changes in predation risk resulting from changes in flow and water temperature.
- Cause significant changes in disease risk resulting from changes in water temperature.
- Cause significant changes in southern Delta and estuarine habitat resulting in changes in SJR inflows and export effects.

A significant impact under these thresholds would result in a significant impact on aquatic resources. Where appropriate, specific quantitative or qualitative criteria are described in Section 7.4.2, *Methods and Approach*, for evaluating these thresholds.

7.4.2 Methods and Approach

This section describes the methods and approach for analyzing the effects of the LSJR and SDWQ alternatives.

LSJR Alternatives

This chapter evaluates the potential aquatic resource impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow[14] requirement and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. The impact analysis for aquatic resources evaluates expected aquatic species responses to changes in environmental conditions under the LSJR alternatives.

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[14] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

Impacts were evaluated based on expected changes in the environment relative to the temporal and spatial occurrence of indicator species and applicable life stages for which impact mechanisms and environmental requirements, or tolerances, are sufficiently understood to support an analysis. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses. The methods used in the analysis varied by geographic area, species life stages, and environmental conditions, and depended largely on the best available scientific information.

For purposes of impact assessment, the plan area has been divided into the following geographic areas.

- The major reservoirs: New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure.
- The three eastside tributaries: Stanislaus, Tuolumne, and Merced Rivers.
- LSJR (Merced River confluence with the SJR downstream to Vernalis).
- The southern Delta.

Because impacts have been evaluated based on predicted effects on indicator species and their specific life stages, each impact discussion is organized by the relevant life stage of the indicator species in the three eastside tributaries and LSJR, as appropriate. These species include coldwater reservoir fish (i.e., rainbow trout[15]), anadromous fish (i.e., fall-run Chinook salmon and steelhead), and warmwater reservoir fish (i.e., largemouth bass). Specific indicator species were selected because they are either native species whose populations in California are declining and/or have received a special-status designation by federal or state resource agencies, or they are recreationally important game fish species. Additionally, these indicator species would be sensitive to the environmental changes expected to result from the LSJR alternatives in each of the geographic areas comprising the plan area. Furthermore, these species have utility in evaluating broader ecosystem and community-level effects of these changes on aquatic resources. For example, the results of the impact analysis on Chinook salmon and steelhead are considered indicative of effects on other native fishes because of the broad ecological benefits of natural flow variability restoration efforts aimed at anadromous salmonids on other native fish communities. A general discussion of the potential responses of, and impacts on, other fish species under the LSJR alternatives are qualitatively discussed where appropriate (i.e., Impacts AQUA-3, AQUA-4, and AQUA-10).

In order to analyze the potential impacts from the LSJR alternatives on indicator species relative to the thresholds discussed above, the impact analysis focuses on the effects of changes in flows and reservoir levels and resultant environmental conditions on indicator species. Changes in flow or reservoir levels directly relate to the quantity and quality of available habitat for various life stages of aquatic species and, therefore, also to population distribution, numbers, and dynamics (see Appendix C, *Technical Analysis on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*).

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[15] For the purposes of this document, rainbow trout refers to *O. mykiss* populations above impassable dams while steelhead refers to *O. mykiss* populations below these dams.

Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) from February–June and adaptive implementation, as described in Chapter 3, *Alternatives Description*. Adaptive implementation could change the volume, rate, or timing of water released February–June. While the adaptive implementation approaches are common to all alternatives, the specific changes vary between the alternatives and may vary by the adaptive implementation approach being implemented, as described in Appendix K. As discussed in Chapter 3, the intent of adaptive implementation is to provide flexibility in meeting biological goals based on monitoring and data collection, to best support ecosystem functions from February–June, as well as support biological needs outside of that time frame. Quantitative or qualitative evaluations were performed in this chapter to evaluate the impacts of the LSJR alternatives. The evaluations used a variety of data sources, such as results from the Water Supply Effects (WSE) models of diversions, reservoir operations, streamflow, and results from the water temperature model. Details of the models and results are presented in Chapter 5, *Surface Hydrology and Water Quality*; Appendix F.1, *Hydrologic and Water Quality Modeling*; and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*.

In this chapter, hydrologic conditions related to aquatic resources are often described using cumulative distribution tables. The cumulative distribution of a particular variable (e.g., flow at a location or temperature at a location) provides a basic summary of the distribution of values. The percentile (i.e., percent cumulative distribution) associated with each value indicates the percent of time that the values were less than the specified value. For example, a 10th percentile value of 2 indicates that 10 percent of the time, the values were less than 2. The 0th percentile is the minimum value, the 50th percentile is the median value, and the 100th percentile is the maximum value. The 10th and 90th percentiles represent relatively low and relatively high values and are representative of multiple years rather than the 1 year with the highest value and the 1 year with the lowest value.

Impacts on indicator species were evaluated by applying one or more of the following general methods.

- Comparison of quantitative simulations: Quantitative output from modeling tools were used for direct comparisons between baseline conditions and the LSJR alternatives to identify effects on aquatic resources.
- Interpretation/extrapolation from quantitative simulations: Output of quantitative models were interpreted/extrapolated to describe effects on aquatic resources.
- Interpretation/extrapolation and qualitative assessment: Existing data and information from previous studies were used to interpret/extrapolate the effects on aquatic resources and to provide a qualitative assessment.

Table 7-7 summarizes the criteria that were evaluated and the habitat variables, biological criteria, and the modeling tools or data used.

Table 7-7. A Summary of the Impact Thresholds, Variables, Criteria, and Data or Methods Used (see also Table 7-1)

Impact Thresholds	Environmental or Habitat Variable	Impact Criteria	Data and Method Used
Impact AQUA-1: Changes in spawning success and habitat availability for warmwater species resulting from changes in reservoir water levels	• Frequency/magnitude of reservoir drawdowns during primary spawning and rearing periods	• Reservoir level fluctuations of 15 feet or more	• Hydrologic/reservoir operations model (Water Supply Effects [WSE] model) • Relationships between reservoir storage and water surface elevation
Impact AQUA-2: Changes in availability of coldwater species reservoir habitat resulting from changes in reservoir storage	• Reservoir storage (end-of-September)	• Storage (water volume) used as an indicator of changes in coldwater habitat availability	• Hydrologic/reservoir operations model (WSE model)
Impact AQUA-3 : Changes in quantity/quality of physical habitat for spawning and rearing resulting from changes in flow	• Frequency/magnitude of changes in spawning and rearing weighted usable area (WUA) • Frequency/magnitude of changes in floodplain inundation area	• WUA and floodplain inundation area	• WUA-discharge relationships • Floodplain inundation area-flow relationships
Impact AQUA-4: Changes in exposure of fish to suboptimal water temperatures resulting from changes in reservoir storage and releases	• Frequency of 7-day averages of the daily maximum water temperatures exceeding criteria	• Water temperature criteria (USEPA criteria)	• Hydrologic/reservoir operation model (WSE model) • River temperature model
Impact AQUA-5: Changes in exposure to pollutants resulting from changes in flow	• Dilution effect of flow on pollutant concentrations • Effect of water temperature on exposure/sensitivity of fish to pollutants	• 50% increase in baseline concentrations	• Published literature • Qualitative evaluation
Impact AQUA-6: Changes in exposure to suspended sediment and turbidity resulting from changes in flow	• Frequency of sediment-mobilizing flows	• Flow thresholds for mobilization of gravel and fine sediment	• Published literature • Qualitative evaluation

Impact Thresholds	Environmental or Habitat Variable	Impact Criteria	Data and Method Used
Impact AQUA-7: Changes in redd dewatering resulting from flow fluctuations	• Frequency/magnitude of flow reductions exceeding depth thresholds during primary spawning and incubation periods	• Habitat suitability criteria (spawning depth preferences and egg pocket depths)	• Hydrologic/reservoir operations model (WSE model) • Flow-depth relationships • Habitat suitability criteria
Impact AQUA-8: Changes in spawning and rearing habitat quality resulting from changes in peak flows	• Frequency/magnitude of gravel-mobilizing flows	• Flow thresholds for gravel mobilization	• Hydrologic/reservoir operations model (WSE model)
Impact AQUA-9: Changes in food availability resulting from changes in flow and floodplain inundation	• Frequency/magnitude of floodplain inundation	• Floodplain inundation area	• Published literature • Qualitative evaluation
Impact AQUA-10: Changes in predation risk resulting from changes in flow and water temperature	• Frequency/magnitude of habitat availability and suboptimal water temperatures	• WUA, floodplain inundation area, and USEPA water temperature criteria for juvenile rearing and outmigration life stages	• Impact AQUA-3 and Impact AQUA-4 results • Published literature • Qualitative evaluation
Impact AQUA-11: Changes in disease risk resulting from changes in water temperature	• Water temperatures associated with increased incidence of disease	• Temperature thresholds for disease incidence in indicator species	• Published literature • Qualitative evaluation • Impact AQUA-4 results
Impact AQUA-12: Changes in southern Delta and estuarine habitat resulting in changes in SJR inflows and export effects	• Change in magnitude of Delta exports in relation to SJR inflows	• Potential effect on fish distribution, entrainment risk, and estuarine habitat quality	• Hydrologic/reservoir operations model (WSE model) • Rules and objectives governing Delta operations • Qualitative evaluation

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, which would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.

4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (for example monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water. For example, terrestrial riparian species could benefit by receiving additional flows during key germination times in the late spring.

The quantitative results included in the figures, tables, and text of this chapter present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). The modeling results also reflect some adjustments in the allocation of flows (as might occur under adaptive implementation method 3 above) to prevent adverse temperature effects in years in which strict adherence to the unimpaired flow percentages results in predicted water temperatures that exceed the significance thresholds for sensitive life stages in the summer and fall (e.g., Chinook salmon spawning and incubation). In practice, such allocations would be implemented in accordance with the adaptive implementation process described above, which would consider a full range of potential flow management methods (methods 1, 2, 3, and 4 above) to maximize fisheries benefits while balancing the needs of other beneficial uses. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling.*

The below subsections provide additional information regarding specific methodologies used for Impact AQUA-3 (changes in quantity/quality of physical habitat for spawning and rearing resulting from changes in flow) and Impact AQUA-4 and Impact AQUA-11 (changes in disease risk resulting from changes water temperature), as well as for Impact AQUA-6 and Impact AQUA-8 (changes in spawning and rearing habitat quality resulting from changes in peak flows).

Physical Habitat Availability

Changes in flow under the LSJR alternatives could affect the quantity and quality of Chinook salmon and steelhead spawning and rearing habitat through changes in the extent of suitable water depths, velocities, substrate types, and other physical attributes of the stream environment. The effects of flow on Chinook salmon and steelhead physical habitat availability were evaluated using two flow-based habitat indices: weighted usable area (WUA) and floodplain inundation area. Both indices were necessary to address changes in habitat availability for the juvenile rearing life stages over the full range of modeled flows.

WUA is a measure of the quantity and quality of habitat for a given species and life stage and is generally defined as the surface area of a stream having a certain combination of water depths, velocities, and other physical attributes that define suitable habitat for that species and life stage. The relationship between WUA and streamflow is a key element of the Instream Flow Incremental Methodology (IFIM) (Bovee et al. 1998). WUA is expressed in terms of square feet or square feet per unit distance (e.g., square feet per 1,000 linear feet of stream). WUA-discharge relationships were developed for Chinook salmon and steelhead spawning, fry rearing, and juvenile rearing life stages as part of a number of instream flow studies conducted on the Stanislaus, Tuolumne, and Merced Rivers (Bowen et al. 2012; MID 2013; Stillwater Sciences 2013). WUA-discharge relationships were available for all three Chinook salmon and steelhead life stages, except for the Stanislaus River, where a WUA-discharge relationship for steelhead spawning was not available. For Impact AQUA-3, existing WUA-discharge relationships were applied to the WSE modeling results to evaluate changes in the quantity and quality of Chinook salmon and steelhead spawning and rearing habitat in key months over the 82-year modeling period.

Since the WUA-discharge relationships are limited to the range of flows that generally fall within the bankfull width of the channel, the floodplain inundation-flow relationships were used to evaluate potential changes in juvenile rearing habitat within the upper range of flows that inundate adjacent floodplains. The primary sources for the floodplain inundation-flow relationships were USFWS 2008; USFWS 2011, 2012, 2013; and cbec 2010 (see Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, Section 19.3, *Floodplain Inundation*). These relationships define changes in wetted floodplain inundation area (above bankfull thresholds) as a function of flow.

Peak Flows

Potential effects of the LSJR alternatives on the frequency and magnitude of flow events capable of inducing sediment transport in the upper and lower reaches of the Stanislaus, Tuolumne, and Merced Rivers were evaluated to determine the potential for changes in exposure of fish to increases in suspended sediment concentrations and turbidity (Impact AQUA-6) and changes in spawning gravel quality resulting from gravel mobilization (Impact AQUA-8). Under baseline conditions, gravel transport is estimated to occur at flows between 5,000 and 8,000 cfs in the Stanislaus River (Kondolf et al. 2001), between 7,050 and 9,800 cfs in the upper reaches of the Tuolumne River (McBain and Trush 2000), and at flows greater than 4,800 cfs in the upper reaches of the Merced River (Stillwater Sciences 2001; Kondolf et al. 1996). Flows below these levels (above approximately 2,000–3,000 cfs) can mobilize finer sediment in the mid- to lower sand-bedded portions of these tributaries, potentially increasing suspended sediment and turbidity in the lower reaches of the three eastside tributaries and the LSJR. These flows served as thresholds for evaluating the potential for impacts on indicator species and aquatic habitat resulting from changes in the frequency and magnitude of bed-mobilizing flows in the Stanislaus, Tuolumne, and Merced Rivers.

Water Temperature and Dissolved Oxygen

Impacts of changes in water temperatures on indicator species were evaluated using the San Joaquin River Basin-Wide Water Temperature Model (temperature model) developed by Resource Management Associates for CALFED using the USACE HEC-5Q simulation model (CALFED 2009). The temperature model provides a basin-wide evaluation of temperature response at 6-hour intervals for alternative conditions. The geographic extent of the model includes the Stanislaus, Tuolumne, and Merced River systems from their confluences with the LSJR to upstream of the major reservoirs (New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure, respectively). The downstream extent of the model is Mossdale on the LSJR. See Appendix F.1, *Hydrologic and Water Quality Modeling*, for a full discussion of this model and its application.

Daily water temperature model results of LSJR Alternatives 2, 3, and 4 were quantitatively assessed to determine the changes in the frequency of potentially stressful water temperatures at key locations and months during the 1970–2003 temperature modeling period. The months and locations generally coincide with the occurrence of each life stage and the maximum water temperatures potentially encountered by individual life stages within each geographic area. This information is incorporated into Impact AQUA-4.

Although water temperature can affect DO levels, and both factors are related to apparent blockage and delays in migration of adult salmon in the Delta (see Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*), adverse effects associated with low DO levels have not been documented in reaches of the SJR or the three eastside tributaries. Therefore, DO levels are expected to remain within acceptable levels and could potentially increase in response to higher flows and cooler temperatures under the LSJR alternatives, as discussed under Impact AQUA-4.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

In general, most fish species identified in Table 7-2 spend the majority or a significant portion of their life history in the Bay-Delta and are accustomed to variations in salinity. Specific salinity information for fish species is presented in Section 7.2.1, *Fish Species*. Indicator species are able to tolerate salinity changes within the range of 0.2 dS/m (0.134 ppt) and 1.2 dS/m, (0.768 ppt), as these salinity levels are within the general historical salinity conditions of the southern Delta. As described in Chapter 5, *Surface Hydrology and Water Quality*, reservoir releases are currently increased in order to meet the existing salinity objectives of maintaining EC below 1.000 dS/m (1,000 μS/cm) (0.67 ppt) for September–March and below 0.700 dS/m (700 μS/cm) (0.37 ppt), for April–August in the SJR at Vernalis. Changes in EC that may occur downstream of Vernalis are dependent on conditions at Vernalis and within the Delta. Under the SDWQ alternatives, there would be no change in operations affecting Delta salinity relative to baseline. This is because EC at Vernalis would be maintained at or below 0.7 dS/m (0.37 ppt) April–August and 1.0 dS/m (0.67 ppt) September–March through the program of implementation, as it is under the current objectives. However, under the SDWQ alternatives, the Vernalis and southern Delta salinity objectives would be changed to a year-round value of either 1.0 dS/m (0.67 ppt) or 1.4 dS/m (0.94 ppt), under SDWQ Alternative 2 or 3, respectively. This would provide some assimilative capacity downstream of Vernalis and protect beneficial agricultural uses. Therefore, the general historic range of salinity (between 0.200 [0.134 ppt] and 1.200 dS/m [0.77 ppt]) would remain unchanged under SDWQ Alternatives 2 and 3. These changes are not expected to increase exposure of sensitive fish species to salinity levels that may adversely affect migration conditions or spawning habitat suitability in the LSJR due to their low levels of salinity. The modeling results indicated that under SDWQ Alternatives 2 or 3, exceedances (described in Section 7.3.2, *State [Regulatory Background]*) would not increase relative to baseline and the salinity in the LSJR and southern Delta would remain similar to baseline or be reduced (Appendix F.1, Section F.1.5.2, *Salinity Modeling Results*). Consequently, there would be little to no change from baseline; therefore, the SDWQ alternatives are not discussed further in this chapter.

7.4.3 Impacts and Mitigation Measures

Impact AQUA-1: Changes in spawning success and habitat availability for warmwater species resulting from changes in reservoir water levels

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Reservoir water level changes associated with the flow releases under the LSJR alternatives could impact recreationally important warmwater reservoir species due to resultant changes in the availability of habitat. The three eastside tributary reservoirs (New Melones, New Don Pedro, and Lake McClure) support several warmwater species that inhabit surface waters and shallow areas near shore (the littoral zone) (USBR 2011). Water level fluctuations resulting from reservoir operations (for irrigation, power generation, reservoir recharge, flood control, downstream flow releases, etc.) can impact habitat quantity and quality, particularly in the shallow-water areas.

Water level fluctuations can have a direct effect on largemouth bass and other warmwater fish that construct their nests in shallow water habitat (USBR 2011). Nearshore spawning species can be affected when reservoir levels rise with snowmelt capture. Rising water levels result in increased water depth of largemouth bass nests, potentially exposing them to water temperatures that may be too cold for the developing eggs (USBR and DWR 2003). Cold water slows the development of the eggs and larvae and, because eggs and larvae are highly vulnerable to predation or infection by fungi, longer development times can substantially reduce survival (USBR 2011). Extensive drawdown of reservoir water levels can also result in declines in reservoir fish species populations through direct effects on spawning success (due to nest abandonment or stranding) and habitat availability for spawning and rearing life stages. Water level fluctuations also inhibit development of shoreline vegetation, which provides cover and feeding substrates for many warmwater fish species in reservoirs. Vegetation also stabilizes shoreline sediments, reducing erosion and sedimentation. Consequently, increases in water level fluctuations could affect reservoir fish species indirectly through effects on vegetation (USBR and DWR 2003).

To assess impacts on warmwater fish species due to changes in reservoir levels under the LSJR alternatives, changes in the frequency and magnitude of reservoir level fluctuations were evaluated during the months of April–September. This period corresponds to the primary spawning, incubation, and early rearing period for largemouth bass and other warmwater species and, thus, the period when these species are most sensitive to reservoir level fluctuations. During this period, a monthly drop in elevation of 15 ft or more was used to evaluate the frequency of events that could have adverse effects on warmwater fish species based on the spawning preferences of largemouth bass. Typical spawning depths for largemouth bass range from the surface to about 15 ft (PG&E 2000; USBR 2011). Therefore, a drop in elevation of 15 ft per month during the spawning season could result in substantial effects on spawning success. It was also assumed that fluctuations of this magnitude (increases or decreases in reservoir levels) could also adversely affect spawning and rearing success through effects on water temperature, vegetation success, and shallow water habitat availability. A 10 percent increase in the occurrence of 15 foot fluctuations compared to baseline conditions was considered to be significant. A decrease in the occurrence of water level fluctuations of this magnitude would result in a more stable environment for the spawning and rearing life stages of warmwater species and, consequently, would not be considered a significant impact.

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, the percentage of months in which water level fluctuations of 15 ft or more would occur at New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure during April–September would be reduced compared to baseline conditions (Tables 7-8a, 7-8b, and 7-8c). These results generally reflect more stable habitat conditions during the largemouth bass spawning and rearing season (April–September), resulting in improved habitat conditions for largemouth bass and other warmwater species. Therefore, adverse impacts on warmwater reservoir species would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, the percentage of months in which water level fluctuations of 15 ft or more would occur at New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure during April–September would be further reduced compared to LSJR Alternative 2 (Tables 7-8a, 7-8b, and 7-8c). Overall, more stable reservoir levels through the spawning and rearing season for largemouth bass and other warmwater species would further improve habitat conditions and result in beneficial effects on these species. Therefore, adverse impacts on warmwater reservoir species would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, the percentage of months in which water level fluctuations of 15 ft or more would occur at New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure during April–September would be further reduced compared to LSJR Alternative 3 (Tables 7-8a, 7-8b, and 7-8c). Overall, spawning and rearing habitat conditions for largemouth bass and other warmwater species would be further improved, resulting in beneficial effects on these species. Therefore, adverse impacts on warmwater reservoir species would be less than significant.

Table 7-8a. Percent of Time Greater than or Equal to 15-foot Change in Elevation from Previous Month for New Melones Reservoir (Average)

	Apr	May	Jun	Jul	Aug	Sep
Baseline	13	27	12	17	7	1
LSJR Alternative 2	5	18	6	2	0	0
Change from Baseline	-8	-9	-6	-15	-7	-1
LSJR Alternative 3	2	9	4	4	1	0
Change from Baseline	-11	-18	-8	-13	-6	-1
LSJR Alternative 4	0	0	0	1	0	0
Change from Baseline	-13	-27	-12	-16	-7	-1

Note: Negative numbers indicate a reduction in 15-foot fluctuations.

Table 7-8b. Percent of Time Greater than or Equal to 15-foot Change in Elevation from Previous Month for New Don Pedro Reservoir (Average)

	Apr	May	Jun	Jul	Aug	Sep
Baseline	4	21	22	48	26	0
LSJR Alternative 2	4	18	16	40	26	0
Change from Baseline	0	-3	-6	-8	0	0
LSJR Alternative 3	2	9	12	28	22	0
Change from Baseline	-2	-12	-10	-20	-4	0
LSJR Alternative 4	0	5	5	6	5	0
Change from Baseline	-4	-16	-17	-42	-21	0

Note: Negative numbers indicate a reduction in 15-foot fluctuations.

Table 7-8c. Percent of Time Greater than or Equal to 15-foot Change in Elevation from Previous Month for Lake McClure (Average)

	Apr	May	Jun	Jul	Aug	Sep
Baseline	42	74	22	81	93	26
LSJR Alternative 2	35	62	5	72	87	9
Change from Baseline	-7	-12	-17	-9	-6	-17
LSJR Alternative 3	23	46	7	61	77	11
Change from Baseline	-19	-28	-15	-20	-16	-15
LSJR Alternative 4	11	18	6	21	48	13
Change from Baseline	-31	-56	-16	-60	-45	-13

Note: Negative numbers indicate a reduction in 15-foot fluctuations.

Impact AQUA-2: Changes in availability of coldwater species reservoir habitat resulting from changes in reservoir storage

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Changes in reservoir storage resulting from the LSJR alternatives could change the volume of cold water (hypolimnetic zone) in the reservoirs and the availability of coldwater habitat for recreationally important salmonids such as rainbow trout and kokanee. The hypolimnetic zone forms in the deepest levels of reservoirs during thermal stratification that occurs during spring, summer, and early fall months. Surface water warmed by the air and solar radiation during the spring and summer floats on top of the cooler, denser water of the hypolimnetic zone. The depth of the warmer surface water layer can vary but is generally 15–30 ft deep in most California reservoirs (including New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure) (EA EST 1999). Thus, reservoir drawdown can affect the volume of cold water below this surface layer, potentially limiting the availability of usable habitat for coldwater reservoir fishes.

In order to evaluate impacts on coldwater storage and resulting habitat for coldwater fish species, end-of-September storage levels in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure were compared to baseline. The end-of-September storage was used as a basis for comparison because it typically represents the month at the end of the summer irrigation season when reservoir storage and coldwater habitat availability are at their lowest levels. While the amount of actual habitat cannot be quantified, the end-of-September storage levels are utilized as an indicator of the amount of summer habitat available to coldwater reservoir species. In the absence of quantitative information relating reservoir storage to effects on habitat availability for coldwater fish, the potential for significant impacts was assumed to exist if reservoir storage levels in September are reduced by 10 percent or more relative to baseline conditions. This is considered a reasonable criterion given the large seasonal and annual fluctuations in reservoir storage experienced by fish in reservoirs and the dependence of the reservoir fisheries on hatchery trout and salmon stocking programs. Tables 7-9a, 7-9b, and 7-9c show the changes in end-of-September elevation for the three reservoirs compared to baseline.

Table 7-9a. Percent Change in End-of-September Storage from Baseline for New Melones Reservoir

Percentile	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Minimum	-5	-23	-47
10	0	-16	-29
20	0	-9	-21
30	3	-3	-16
40	4	-1	-6
50	7	1	-2
60	12	5	3
70	18	17	13
80	27	33	37
90	81	84	92
Maximum	582	573	534
Average	42	39	33

Note: Negative percentages indicate a decrease in storage levels relative to baseline conditions.

Table 7-9b. Percent Change in End-of-September Storage from Baseline for New Don Pedro Reservoir

Percentile	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Minimum	-16	-29	-37
10	-5	-18	-26
20	-3	-15	-22
30	-2	-13	-18
40	-2	-11	-14
50	0	-5	-7
60	0	-1	-3
70	0	0	0
80	2	3	10
90	7	8	16
Maximum	33	30	44
Average	1	-6	-6

Note: Negative percentages indicate a decrease in storage levels relative to baseline conditions.

Table 7-9c. Percent Change in End-of-September Storage from Baseline for Lake McClure

Percentile	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Minimum	-12	-32	-39
10	-1	-21	-27
20	0	-14	-20
30	0	-3	-10
40	0	-1	-2
50	4	0	0
60	15	14	19
70	35	38	29
80	91	82	60
90	139	142	122
Maximum	157	206	181
Average	36	31	23

Note: Negative percentages indicate a decrease in storage levels relative to baseline conditions.

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, modeled September storage levels in New Melones Reservoir were equal to or higher than baseline levels in most years; average September storage is predicted to increase by 48 percent with annual levels ranging from little or no change to a 582-percent increase compared to baseline levels (Table 7-9a). In New Don Pedro Reservoir, modeled September storage levels differed only slightly from baseline levels in most years, averaging 1 percent over the 82-year modeling period (Table 7-9b). In Lake McClure, average September storage is predicted to increase by 36 percent with annual levels ranging from a 12 percent decrease to a 157 percent increase compared to baseline levels (Table 7-9c). Therefore, average summer storage levels in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure under LSJR Alternative 2 would be similar to or higher than baseline levels, resulting in no long-term adverse impacts on coldwater fish habitat. Negative impacts on coldwater fish species would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, no substantial long-term impacts on the availability of coldwater fish habitat in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure are expected to occur. Differences in average September reservoir storage from baseline levels ranged from a 6 percent decrease in New Don Pedro Reservoir to a 39 percent increase in New Melones Reservoir (Tables 7-9a, 7-9b, and 7-9c). Adverse impacts on coldwater fish species would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, no substantial long-term adverse impacts on the availability of coldwater fish habitat in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure are expected to occur. Differences in average September reservoir storage from baseline levels ranged from a 6 percent decrease in New Don Pedro Reservoir to a 33 percent increase in New Melones Reservoir

(Tables 7-9a, 7-9b, and 7-9c). Adverse impacts on coldwater fish species would be less than significant.

Impact AQUA-3: Changes in the quantity/quality of physical habitat for spawning and rearing resulting from changes in flow

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

The LSJR alternatives could affect the quantity and quality of Chinook salmon and steelhead spawning and rearing habitat through changes in the extent of suitable water depths, velocities, substrate types, and other physical attributes of the stream environment. The following assessment focuses on potential impacts of the alternatives on Chinook salmon and steelhead populations because of their sensitivity to flow and other flow-related variables (e.g., water temperature) and because of their utility as key indicators of the responses of other native fish species to altered flow regimes in regulated rivers. As previously discussed in Section 7.4.2, *Methods and Approach*, the results of this assessment are considered indicative of effects on other native fishes; however, a general qualitative discussion of the potential responses of other fish species to the proposed alternatives is provided below.

As described in Section 7.4.2, the effects of flow on Chinook salmon and steelhead physical habitat availability were evaluated using two flow-based habitat indices: WUA and floodplain inundation. The WUA-flow relationships were used to evaluate changes in spawning and rearing habitat within the lower range of flows that generally fall within the bankfull width of the channel while the floodplain inundation-flow relationships were used to evaluate potential changes in rearing habitat within the upper range of flows that inundate adjacent floodplains. Table 7-10 summarizes the flow ranges used to evaluate changes in spawning and rearing WUA and floodplain inundation for each of the three eastside tributaries.

Table 7-10. Flow Ranges used to Evaluate Changes in Weighted Usable Area (WUA) and Floodplain Inundation under the LSJR Alternatives for the Stanislaus, Tuolumne, and Merced Rivers

	WUA Flow Range (cfs)	WUA Flow Range (cfs)	Floodplain Inundation Flow Range (cfs)
Stanislaus River	Spawning	25–1,300	1,000–5,000
	Fry/juvenile rearing	250–1,500	
Tuolumne River	Spawning	50–1,200	1,100–5,000
	Fry/juvenile rearing	50–1,200	
Merced River	Spawning	75–1,250	
	Fry/juvenile rearing	75–1,250	1,000–5,000

Impacts on Chinook salmon and steelhead spawning and rearing habitat were evaluated by comparing the magnitude and frequency of WUA and floodplain inundation area under each of the LSJR alternatives to baseline conditions over the 82-year modeling period. The analysis first presents modeled baseline flows and associated habitat metrics for the indicator species, followed by conditions under each LSJR alternative. Reductions in average WUA of 10 percent or more were considered sufficient to result in a significant impact on fry and juvenile production. Because modeled winter and spring flows frequently exceeded the range of flows for which WUA values could be determined, impact determinations for effects on fry and juvenile rearing habitat also considered predicted changes in floodplain inundation and water temperatures (see Impact AQUA-4) associated with these higher flows. To address uncertainties in floodplain inundation duration associated with the use of monthly modeled flows, reductions of 10 percent or more in the frequency of floodplain inundation areas of 50 acres or more were considered sufficient to result in a significant impact on fry and juvenile production. A criterion of 10 percent change, in combination with professional judgment, is used to determine whether impacts are significant. Due to lack of quantitative relationships between a given change in environmental conditions and relevant population metrics (e.g., survival or abundance), 10 percent was selected because that value is assumed to be high enough to reveal significant change to a condition while a lessor amount of change could be due in error in the various analytical and modeling techniques. Therefore, 10 percent provides a conservative qualitative basis to evaluate whether adverse effects to sensitive species at the population level will occur.

Baseline

Modeled baseline flows and associated habitat conditions for the indicator species and their key life stages are summarized below. As described in Chapter 5, *Surface Hydrology and Water Quality*, modeled baseline flows reflect current flow management operations and regulatory requirements in each of three eastside tributaries. Tables 7-11a, 7-11b, and 7-16c summarize baseline habitat conditions as well as expected changes from baseline conditions under each of the LSJR alternatives (discussed in subsequent sections).

Spawning

Chinook Salmon Spawning

Under baseline conditions, WUA values for Chinook salmon spawning in the Stanislaus, Tuolumne, and Merced Rivers in October averaged 47 percent, 80 percent, and 87 percent, respectively, of maximum WUA (Tables 7-11a, 7-11b, and 7-11c). These values reflect current operations that include the release of pulse flows in October for adult salmon attraction. Following these attraction flows, flows are generally maintained near optimal levels for spawning; monthly WUA values in the Stanislaus, Tuolumne, and Merced Rivers averaged 82–94 percent of maximum WUA values in November and December (Tables 7-11a, 7-11b, and 7-11c).

Steelhead Spawning

WUA-discharge relationships for steelhead spawning are only available for the Tuolumne and Merced Rivers. Based on those years in which WUA values could be evaluated (approximately 50–80 percent of the years had modeled flows within the range of the WUA-discharge relationships), average WUA values in January-March were 77–80 percent of maximum WUA for the Tuolumne River and 90–95 percent of maximum WUA for the Merced River (Tables 7-12a and 7-12b).

Table 7-11a. Distribution of October–December Weighted Usable Area (WUA) Values for Chinook Salmon Spawning on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	October				November				December			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	474,370	433,632	197,130	197,130	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
20	481,334	477,852	223,308	223,308	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
30	492,192	488,692	261,075	261,075	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
40	511,207	508,925	282,107	282,107	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
50	520,714	518,813	341,388	341,388	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
60	736,112	526,419	404,990	404,990	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
70	747,448	739,051	462,599	462,599	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
80	823,236	757,105	496,408	501,506	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
90	827,960	827,487	613,735	614,040	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917	1,117,917
Max	855,490	855,490	855,490	855,490	1,299,496	1,299,496	1,299,496	1,299,496	1,299,496	1,299,496	1,299,496	1,299,496
Average	610,299	596,082	387,419	388,672	1,126,466	1,128,736	1,123,000	1,124,627	1,111,863	1,108,741	1,096,405	1,107,432
% Max WUA	47	46	30	30	87	87	86	87	86	85	84	85
Change	—	-14,217	-222,880	-221,627	—	2,270	-3,466	-1,839	—	-3,121	-15,458	-4,431
% Change	—	-2	-37	-36	—	0	0	0	—	0	-1	0

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-11b. Distribution of October–December Weighted Usable Area (WUA) Values for Chinook Salmon Spawning on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	October				November				December			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	11,109	11,109	9,855	9,855	13,072	13,072	7,959	7,959	7,020	10,475	13,071	13,071
20	11,336	11,336	10,893	10,893	13,072	13,072	10,880	10,880	13,071	13,071	13,071	13,071
30	13,353	13,353	11,219	11,219	13,072	13,072	13,072	13,072	13,071	13,071	13,071	13,071
40	16,777	16,777	11,843	11,843	15,232	15,232	13,072	13,072	13,071	13,071	15,232	15,232
50	16,777	16,777	13,505	13,505	15,530	15,530	13,072	13,072	15,232	15,232	15,530	15,530
60	16,823	16,823	16,399	16,399	18,817	18,817	15,137	15,137	15,453	15,530	18,817	18,817
70	16,853	16,853	16,853	16,853	18,817	18,817	15,232	15,232	18,817	18,817	18,817	18,817
80	16,901	16,901	16,901	16,901	18,817	18,817	18,817	18,817	18,817	18,817	18,817	18,817
90	17,206	17,206	17,206	17,206	18,817	18,817	18,817	18,817	18,817	18,817	18,817	18,817
Max	17,380	17,380	17,380	17,380	18,817	18,817	18,817	18,817	18,817	18,817	18,817	18,817
Average	14,961	14,961	13,708	13,708	16,209	16,230	13,971	13,971	15,410	15,528	16,203	16,079
% Max WUA	80	80	73	73	86	86	74	74	82	83	86	85
Change	—	0	-1,253	-1,253	—	20	-2,238	-2,238	—	118	793	668
% Change	—	0	-8	-8	—	0	-14	-14	—	1	5	4

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-11c. Distribution of October–December Weighted Usable Area (WUA) Values for Chinook Salmon Spawning on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	October				November				December			
Percentile	Baseline	LSJR Alt 3	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	6,004	6,004	5,923	4,437	—	—	—	—	—	—	—	—
10	17,697	17,501	8,826	8,368	19,906	19,906	10,104	9,229	7,844	7,216	19,906	19,906
20	17,697	17,697	10,780	9,312	19,906	19,906	12,242	10,417	19,906	19,906	19,906	19,906
30	17,697	17,697	17,697	17,697	19,906	19,906	19,906	19,906	19,906	19,906	19,906	19,906
40	17,697	17,697	17,697	17,697	19,906	19,906	19,906	19,906	19,906	19,906	19,906	19,906
50	17,949	17,909	17,795	17,795	19,906	19,906	19,906	19,906	19,906	19,906	19,906	19,906
60	18,311	18,292	18,212	18,212	19,906	19,906	19,906	19,906	19,906	19,906	19,906	19,906
70	18,544	18,531	18,493	18,493	19,906	19,906	19,906	19,906	19,906	19,906	19,906	19,906
80	18,891	18,884	18,877	18,877	19,906	19,906	19,906	19,906	19,906	19,906	19,906	19,906
90	19,383	19,363	19,363	19,363	19,906	19,906	19,906	19,906	19,906	19,906	19,906	19,906
Max	20,185	20,185	20,185	20,185	20,323	20,323	19,906	19,906	20,361	20,361	19,906	20,339
Average	17,755	17,717	15,995	15,728	19,315	19,118	17,365	16,985	18,854	18,885	19,898	19,716
% Max WUA	87	87	78	77	94	93	85	83	92	92	97	96
Change	—	-39	-1,761	-2,027	—	-197	-1,950	-2,330	—	32	1,045	862
% Change	—	0	-10	-11	—	-1	-10	-12	—	0	6	5

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-12a. Distribution of January–March Weighted Usable Area (WUA) Values for *O. mykiss* Spawning in the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	January				February				March			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—
20	27,813	27,813	27,813	27,813	—	—	—	—	—	—	—	—
30	27,813	27,813	27,813	27,813	—	—	—	—	—	—	—	—
40	27,813	27,813	27,813	27,813	27,220	27,343	30,481	11,011	—	—	—	—
50	30,186	30,186	30,186	30,186	27,814	27,814	37,201	37,357	—	28,213	37,637	—
60	30,588	30,588	34,742	37,512	27,814	30,320	37,512	38,229	27,956	30,780	38,677	37,789
70	37,512	37,512	37,512	37,512	30,187	37,168	38,690	40,046	28,528	34,565	40,740	38,667
80	37,512	37,512	37,512	37,512	37,179	37,512	40,251	40,751	30,749	37,662	41,111	39,856
90	38,163	37,512	37,512	37,512	37,512	40,415	41,010	41,329	37,759	38,142	41,350	40,772
Max	41,429	41,259	39,690	38,271	41,402	41,453	41,486	41,467	40,658	41,396	41,478	41,429
Average	33,062	32,824	32,886	33,091	32,003	34,009	37,558	38,542	31,907	34,975	39,265	39,290
% Max WUA		80	79	79 80	77	82	91	93	77	84	95	95
Change	—		-238	-176 29	—	2,006	5,555	6,539	—	3,068	7,358	7,383
% Change	—		-1	-1 0	—	6	17	20	—	10	23	23

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-12b. Distribution of January—March Weighted Usable Area (WUA) Values for *O. mykiss* Spawning in the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	January				February				March			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	20,005	—	1,979	20,797	—	—	—	—	—	—	—	—
20	30,285	27,294	30,285	30,285	—	—	—	—	29,098	29,098	24,766	22,665
30	30,285	30,285	30,285	30,285	27,189	27,189	26,437	20,397	31,319	32,014	30,476	25,628
40	30,285	30,285	30,285	30,285	30,285	30,285	30,285	28,972	33,031	33,031	32,259	27,213
50	30,285	30,285	30,285	30,285	30,285	30,285	30,285	30,285	33,031	33,031	32,938	29,691
60	30,285	30,285	30,285	30,285	30,285	30,285	30,285	30,415	33,031	33,031	33,031	31,262
70	30,285	30,285	30,285	30,285	30,285	30,285	30,521	31,961	33,031	33,031	33,031	31,991
80	30,285	30,285	30,285	30,285	30,550	31,214	31,350	32,574	33,031	33,031	33,129	32,621
90	30,285	30,285	30,285	30,285	32,138	32,295	32,497	32,984	33,031	33,031	33,225	33,031
Max	33,105	31,745	30,742	31,085	33,059	33,059	33,294	33,319	33,324	33,324	33,332	33,278
Average	29,866	29,719	29,951	30,148	30,244	30,430	29,974	30,591	31,821	31,902	31,469	29,482
% Max WUA	90	89	90	90	91	91	90	92	95	96	94	88
Change	—	-147	85	282	—	186	-270	347	—	81	-351	-2,339
% Change	—	0	0	1	—	1	-1	1	—	0	-1	-7

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Juvenile Rearing

Chinook Salmon Rearing

In the Stanislaus River, baseline WUA values during the primary Chinook salmon fry rearing period (January–March) could not be evaluated in most years because modeled flows were frequently lower than the lowest flow defined by the WUA-discharge relationship (250 cfs) (Table 7-13a). However, minimum modeled flows in these months were between 200 and 250 cfs, indicating that physical habitat for fry was near maximum WUA levels in most years. In the Tuolumne and Merced Rivers, average WUA values for fry rearing in January–March were 67–69 percent of maximum WUA in the Tuolumne River and 73–79 percent of maximum WUA in the Merced River (Tables 7-13b and 7-13c). During the spring (April–May), average WUA values for juvenile rearing were 93 percent of maximum in the Stanislaus River, 71–73 percent of maximum WUA in the Tuolumne River, and 77–79 percent of maximum WUA in the Merced River (Tables 7-14a, 7-14b, and 7-14c).

Based on floodplain inundation area-flow relationships, the frequency of floodplain inundation in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR generally peaks in spring. Under baseline conditions, floodplain inundation events of 50 acres occurred less than 10 percent (February) to 50 percent of the time (April) in the Stanislaus River, 20–50 percent of the time in the Tuolumne River, and less than 10 percent to 20 percent of the time in the Merced River (Tables 7-15a, 7-15b, and 7-15c). In the LSJR between the Stanislaus River and Mossdale, floodplain inundation events of 50 acres or more occurred approximately 50–70 percent of the time during the winter and spring months (Table 7-15d). Over the 82-year modeling period, average floodplain inundation areas ranged from 25–58 acres in the Stanislaus River, 140–288 acres, 11–61 acres in the Merced River, and 257–368 acres in the LSJR.

Steelhead Rearing

Under modeled baseline conditions, average WUA values for steelhead fry rearing in April–May were 79–80 percent of maximum WUA in the Stanislaus River, 60 percent of maximum WUA in the Tuolumne River, and 71 percent of maximum WUA in the Merced River (Tables 7-16a, 7-16b, and 7-16c). During summer (July–September), WUA values for juvenile rearing in the Stanislaus, Tuolumne, and Merced Rivers were near maximum WUA levels (88–99 percent) in the majority of years (Tables 7-17a, 7-17b, and 7-17c). Spring floodplain inundation, which serves as an indicator of floodplain habitat availability for Chinook salmon (as discussed previously), may also benefit juvenile steelhead.

Table 7-13a. Distribution of January—March Weighted Usable Area (WUA) Values for Chinook Salmon Fry Rearing on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	January				February				March			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	299,483
40	—	—	—	—	—	—	1,019,710	1,042,568	—	—	1,028,557	1,053,507
50	—	—	—	—	—	—	1,064,986	1,062,669	—	—	1,157,761	1,078,586
60	—	—	—	—	1,018,481	1,191,481	1,156,870	1,106,239	—	—	1,236,945	1,123,387
70	—	—	—	—	1,251,467	1,304,354	1,264,011	1,225,446	1,061,696	758,151	1,292,039	1,165,445
80	—	—	—	—	1,378,961	1,375,240	1,360,222	1,313,920	1,192,306	1,324,535	1,325,634	1,247,715
90	1,151,203	955,960	—	1,116,986	1,415,577	1,412,503	1,387,049	1,400,040	1,329,759	1,400,644	1,370,218	1,347,493
Max	1,428,081	1,428,081	1,428,081	1,428,081	1,440,002	1,438,466	1,436,392	1,434,682	1,436,584	1,439,713	1,441,726	1,430,761
Average	1,373,521	1,338,934	1,373,537	1,358,813	1,323,857	1,331,339	1,239,735	1,216,413	1,244,847	1,345,838	1,255,020	1,174,619
%MaxWUA	95	93	95	94	92	92	86	84	86	93	87	81
Change	—	-34,587	17	-14,708	—	7,483	-84,121	-107,444	—	100,991	10,173	-70,228
% Change	—	-3	0	-1	—	1	-6	-8	—	8	1%	-6

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-13b. Distribution of January–March Weighted Usable Area (WUA) Values for Chinook Salmon Fry Rearing on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	January				February				March			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—
20	14,976	15,070	19,427	19,427	—	—	—	—	—	—	—	—
30	19,427	19,427	19,427	19,427	—	—	—	—	—	—	—	—
40	19,427	19,427	19,427	19,427	14,967	15,585	15,092	5,970	—	—	—	—
50	19,427	19,427	19,427	19,427	19,427	17,759	16,061	15,198	—	15,035	14,938	—
60	23,795	23,795	23,795	23,795	22,162	19,427	17,595	15,683	19,133	17,773	15,033	15,065
70	24,033	24,033	24,033	24,033	24,033	22,299	19,408	16,776	23,641	19,368	15,567	16,010
80	25,415	25,415	25,415	25,415	25,415	24,033	19,427	17,626	24,860	22,145	17,167	16,721
90	25,415	25,415	25,415	25,415	25,415	25,415	20,906	19,427	25,277	23,785	19,186	17,541
Max	25,415	25,415	25,415	25,415	25,748	25,748	25,575	25,575	25,415	25,415	24,999	23,690
Average	21,943	22,176	22,266	22,170	22,641	21,295	18,704	17,662	22,716	20,554	16,952	16,668
% Max WUA	67	67	68	67	69	65	57	54	69	62	52	51
Change	—	232	322	227	—	-1,346	-3,937	-4,979	—	-2,162	-5,764	-6,048
% Change	—	1	1	1	—	-6	-17	-22	—	-10	-25	-27

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table7-13c. Distribution of January–March Weighted Usable Area (WUA) Values for Chinook Salmon Fry Rearing on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	January				February				March			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	14,236	—	1,426	14,246	—	—	—	—	—	—	—	—
20	15,880	16,277	16,927	16,927	—	—	—	—	15,251	14,599	14,235	14,138
30	16,927	16,927	16,927	16,927	14,412	14,381	14,999	14,149	15,251	15,251	14,497	14,185
40	16,927	16,927	16,927	16,927	15,889	15,674	15,616	14,659	15,251	15,251	14,641	14,328
50	16,927	16,927	16,927	16,927	16,804	16,477	16,343	15,119	15,251	15,251	14,908	14,565
60	16,927	16,927	16,927	16,927	16,927	16,927	16,764	15,614	15,251	15,251	15,245	15,065
70	16,927	16,927	16,927	16,927	16,927	16,927	16,927	16,105	15,251	15,251	15,251	15,251
80	16,927	16,927	16,927	16,927	16,927	16,927	16,927	16,924	15,251	15,251	15,251	15,382
90	16,927	16,927	16,927	16,927	16,927	16,927	16,927	16,927	16,397	16,131	15,939	16,215
Max	18,076	18,076	18,076	18,076	17,962	17,962	17,962	17,962	17,643	17,643	17,643	18,106
Average	16,714	16,785	16,865	16,872	16,487	16,413	16,345	15,880	15,462	15,339	15,072	15,065
% Max WUA	79	79	79	79	77	77	77	75	73	72	71	71
Change	—	71	150	158	—	-74	-142	-607	—	-123	-390	-397
% Change	—	0	1	1	—	0	-1	-4	—	-1	-3	-3

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-14a. Distribution of April–May Weighted Usable Area (WUA) Values for Chinook Salmon Juvenile Rearing on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—
40	—	971,855	—	—	380,917	970,449	—	—
50	976,003	976,279	974,344	—	962,140	995,181	—	—
60	979,154	979,045	986,858	—	997,721	998,312	960,821	—
70	995,523	1,059,687	1,015,866	971,357	1,000,756	1,000,667	998,152	—
80	1,081,724	1,100,114	1,060,045	1,007,751	1,060,480	1,057,038	1,040,421	971,892
90	1,098,041	1,104,825	1,100,217	1,062,885	1,078,859	1,062,724	1,064,422	1,050,303
Max	1,106,958	1,106,958	1,105,873	1,106,068	1,105,972	1,098,514	1,105,688	1,106,079
Average	1,032,093	1,036,895	1,029,708	1,028,204	1,024,737	1,018,267	1,029,138	1,030,211
% Max WUA	93	94	93	93	93	92	93	93
Change	—	4,802	-2,385	-3,889	—	-6,471	4,400	5,474
% Change	—	0	0	0	—	-1	0	1

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-14b. Distribution of April–May Weighted Usable Area (WUA) Values for Chinook Salmon Juvenile Rearing on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—
30	—	—	—	—	9,375	—	—	—
40	—	—	—	—	31,253	—	—	—
50	31,271	31,276	—	—	31,421	31,250	—	—
60	33,517	32,664	—	—	32,574	31,303	—	—
70	39,045	33,687	—	—	39,725	31,705	—	—
80	40,621	37,792	31,333	—	41,270	33,851	—	—
90	45,256	40,630	32,361	—	45,660	39,844	31,263	—
Max	48,644	48,525	42,956	34,518	49,155	49,155	37,943	31,639
Average	38,677	36,354	33,130	32,398	37,553	35,006	32,279	31,609
% Max WUA	73	69	63	61	71	66	61	60
Change	—	-2,323	-5,547	-6,279	—	-2,547	-5,274	-5,944
% Change	—	-6	-14	-16	—	-7	-14	-16

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-14c. Distribution of April–May Weighted Usable Area (WUA) Values for Chinook Salmon Juvenile Rearing on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—
10	16,505	16,515	16,493	—	—	—	—	—
20	17,291	17,821	16,502	—	16,963	16,492	—	—
30	18,026	18,945	16,560	—	17,460	16,584	—	—
40	18,207	20,449	16,735	—	18,819	16,897	—	—
50	22,750	21,509	16,934	16,501	21,506	17,320	—	—
60	26,268	22,821	17,560	16,642	24,763	17,863	16,532	—
70	28,867	24,924	18,014	17,097	27,984	18,821	16,880	—
80	28,867	26,998	18,998	17,572	28,867	20,801	17,252	—
90	28,867	28,604	19,968	18,051	28,867	24,143	17,898	16,837
Max	29,898	29,860	29,616	24,966	29,315	28,867	27,964	23,868
Average	23,105	22,297	18,151	17,490	23,627	19,281	17,728	17,522
% Max WUA	77	75	61	58	79	64	59	59
Change	—	-808	-4,955	-5,616	—	-4,346	-5,899	-6,105
% Change	—	-3	-21	-24	—	-18	-25	-26

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-15a. Distribution of February–May Monthly Floodplain Inundation Area (acres) on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	February				March				April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	0	0	40	0	0	1	66
30	0	0	0	0	0	0	0	0	0	0	20	67	0	0	47	104
40	0	0	0	0	0	0	0	0	0	0	52	90	0	45	67	175
50	0	0	0	0	0	0	0	0	62	63	65	108	48	47	96	228
60	0	0	0	0	0	0	0	6	87	67	82	142	80	48	114	299
70	0	0	0	16	23	80	21	64	91	88	88	163	93	93	158	333
80	0	0	13	92	80	80	80	81	98	90	91	188	100	96	178	376
90	0	21	58	170	81	98	81	134	107	94	98	241	156	131	246	475
Max	600	600	600	731	760	760	760	760	141	100	211	437	223	207	489	789
Avg	25	28	35	54	40	42	35	53	52	47	58	121	58	53	114	241
Change		3	10	29		3	-4	13		-6	6	68		-5	56	183

Note: Gray shading indicates areas of floodplain inundation events of 50 acres (or more).

Table 7-15b. Distribution of February–May Monthly Floodplain Inundation Area (acres) on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	February				March				April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	0	0	0	-5	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	73	0	0	6	256
20	0	0	0	0	0	0	0	0	0	0	0	172	0	0	200	445
30	0	0	0	0	0	0	0	0	0	0	72	296	0	0	301	537
40	0	0	0	0	0	0	0	7	0	0	111	346	0	0	349	600
50	0	0	0	0	80	7	0	63	0	0	233	378	0	0	425	668
60	0	0	0	35	279	183	118	173	71	66	289	456	0	87	469	716
70	276	271	85	331	556	556	382	442	335	330	363	509	34	160	522	765
80	538	498	316	478	629	629	532	541	534	534	498	545	113	243	579	803
90	767	708	634	651	747	732	732	709	708	708	708	617	727	743	730	877
Max	955	955	938	941	1,384	1,384	1,384	1,384	1,090	1,090	1,090	1,090	1,131	1,131	1,131	1,122
Avg	210	200	156	202	288	275	228	247	210	206	266	388	140	180	409	624
Change		-10	-54	-8		-13	-60	-40		-4	57	179		40	269	484

Note: Gray shading indicates areas of floodplain inundation events of 50 acres (or more).

Table 7-15c. Distribution of February–May Monthly Floodplain Inundation Area (acres) on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	February				March				April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	91
30	0	0	0	0	0	0	0	0	0	0	0	2	0	0	10	163
40	0	0	0	0	0	0	0	0	0	0	0	28	0	0	56	199
50	0	0	0	0	0	0	0	0	0	0	0	52	0	0	100	243
60	0	0	0	0	0	0	0	0	0	0	0	89	0	0	134	288
70	0	0	0	48	0	0	0	0	0	0	0	129	0	0	166	310
80	92	103	72	130	0	0	0	0	0	0	19	160	9	44	220	358
90	228	268	219	204	118	118	118	128	0	0	54	194	292	290	293	387
Max	497	492	477	477	473	475	518	473	516	516	516	516	577	577	577	561
Avg	61	64	49	59	33	35	35	39	11	11	21	84	52	56	122	228
Change		3	-12	-2		1	2	6		0	11	73		5	71	176

Note: Gray shading indicates areas of floodplain inundation events of 50 acres (or more).

Table 7-15d. Distribution of February–May Monthly Floodplain Inundation Area (acres) on the Lower San Joaquin River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	February				March				April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	9	9	9	9	0	0	0	0	0	4	4	15	0	1	15	30
10	19	17	19	22	12	12	16	33	12	20	51	92	10	30	67	113
20	25	22	25	35	33	18	39	65	35	41	88	131	34	56	119	210
30	33	31	34	48	36	39	50	81	71	63	108	167	62	73	161	275
40	48	39	45	64	74	58	71	94	96	82	134	219	76	107	202	353
50	78	83	61	87	78	82	97	136	127	111	163	260	125	122	269	460
60	119	124	165	226	172	158	162	210	155	147	193	295	154	169	311	585
70	205	212	231	323	293	294	234	298	206	196	245	351	154	198	384	675
80	398	384	364	438	346	391	354	432	304	325	346	436	254	318	446	749
90	902	868	623	856	764	764	753	736	649	706	731	773	719	815	966	1,349
Max	3,732	3732	3732	3732	7,056	7056	7056	7056	2,346	2346	2462	2702	2,216	2216	2486	3121
Avg	310	313	303	347	368	368	357	389	257	258	296	380	271	296	408	622
Change		4	-7	37		1	-11	21		1	39	123		25	137	352

Note: Gray shading indicates areas of floodplain inundation events of 50 acres (or more).

Table 7-16a. Distribution of April–May Weighted Usable Area (WUA) Values for *O. mykiss* Fry Rearing on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—
40	—	880,929	—	—	346,765	909,509	—	—
50	887,756	886,526	883,451	—	909,807	910,402	—	—
60	984,578	1,018,843	903,609	—	989,735	913,794	879,851	—
70	1,020,728	1,029,690	952,175	880,130	1,027,233	999,610	911,532	—
80	1,040,858	1,034,426	1,024,032	921,562	1,087,910	1,081,429	982,710	882,247
90	1,168,376	1,093,836	1,038,817	992,975	1,191,052	1,159,138	1,029,114	983,524
Max	1,199,719	1,189,427	1,179,879	1,167,557	1,207,082	1,205,837	1,203,347	1,203,347
Average	1,027,420	1,000,879	973,700	960,654	1,037,516	1,009,116	990,151	967,386
% Max WUA	79	77	75	74	80	77	76	74
Change	—	-26,541	-53,720	-66,766	—	-28,400	-47,365	-70,131
% Change	—	-3	-5	-6	—	-3	-5	-7

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-16b. Distribution of April–May Weighted Usable Area (WUA) Values for *O. mykiss* Fry Rearing on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—
30	—	—	—	—	9,199	—	—	—
40	—	—	—	—	31,371	—	—	—
50	30,708	30,708	—	—	31,563	30,643	—	—
60	31,395	31,089	—	—	32,189	31,370	—	—
70	31,824	31,460	—	—	33,437	31,713	—	—
80	33,428	32,756	31,110	—	33,666	32,384	—	—
90	33,554	33,554	32,552	—	33,757	33,437	30,915	—
Max	35,802	35,688	34,475	34,448	36,296	36,296	34,500	34,261
Average	32,579	32,151	32,260	32,794	32,842	32,289	33,133	33,074
% Max WUA	60	59	59	60	60	59	61	60
Change	—	-428	-319	214	—	-553	291	232
% Change	—	-1	-1	1	—	-2	1	1

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-16c. Distribution of April–May Weighted Usable Area (WUA) Values for *O. mykiss* Fry Rearing on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—
10	17,646	17,371	17,290	—	—	—	—	—
20	17,735	17,683	17,473	—	17,464	17,369	—	—
30	17,829	17,812	17,880	—	17,681	17,598	—	—
40	18,758	18,092	18,338	—	18,225	17,773	—	—
50	19,700	18,404	19,281	18,723	18,596	18,251	—	—
60	20,698	19,011	19,802	19,702	20,000	18,605	17,875	—
70	21,549	19,644	20,505	20,878	21,496	19,080	18,972	—
80	21,549	20,577	21,091	22,072	21,549	20,307	20,807	—
90	21,549	21,549	22,358	23,169	21,549	21,551	22,300	21,080
Max	27,965	23,487	23,755	23,629	23,093	23,177	23,715	23,625
Average	19,996	19,064	19,649	21,080	19,771	19,177	20,571	20,955
% Max WUA	71	68	70	75	71	68	73	75
Change	—	-932	-347	1,083	—	-594	800	1,184
% Change	—	-5	-2	5	—	-3	4	6

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-17a. Distribution of July–September Weighted Usable Area (WUA) Values for *O. mykiss* Juvenile Rearing on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternative 2, 3, and 4

	July				August				September			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—
20	—	1,050,765	1,033,694	1,022,273	—	202,751	1,054,778	1,055,222	—	—	—	—
30	1,061,869	1,062,598	1,047,271	1,042,178	1,054,778	1,063,984	1,063,984	1,063,984	—	—	—	—
40	1,062,598	1,062,598	1,054,702	1,051,833	1,063,984	1,063,984	1,063,984	1,065,708	—	—	—	—
50	1,063,407	1,067,201	1,062,598	1,064,900	1,064,100	1,068,587	1,068,587	1,068,587	1,056,988	977,834	1,035,331	—
60	1,067,201	1,067,201	1,067,201	1,070,056	1,068,587	1,068,587	1,068,587	1,071,719	1,066,194	1,066,194	1,043,164	1,033,503
70	1,067,201	1,067,432	1,070,493	1,071,805	1,068,587	1,068,587	1,069,211	1,073,191	1,066,194	1,066,194	1,054,951	1,041,167
80	1,071,805	1,071,805	1,071,805	1,071,805	1,073,191	1,073,191	1,073,191	1,073,191	1,070,797	1,070,797	1,066,194	1,053,387
90	1,071,805	1,071,805	1,071,805	1,071,805	1,073,191	1,073,191	1,073,191	1,073,191	1,070,797	1,070,797	1,070,797	1,070,337
Max	1,073,259	1,073,259	1,073,259	1,073,259	1,073,422	1,073,422	1,073,422	1,073,652	1,073,184	1,073,184	1,071,990	1,071,036
Average	1,062,643	1,061,923	1,059,941	1,056,510	1,067,275	1,067,358	1,067,738	1,066,118	1,067,766	1,059,031	1,056,969	1,052,946
%MaxWUA	99	99	99	98	99	99	99	99	99	99	98	98
Change	—	-721	-2,702	-6,133	—	82	462	-1,157	—	-8,735	-10,797	-14,821
% Change	—	0	0	-1	—	0	0	0	—	-1	-1	-1

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-17b. Distribution of July–September Weighted Usable Area (WUA) Values for *O. mykiss* Juvenile Rearing on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	July				August				September			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	40,296	55,361	55,361	52,596	52,596	52,462	52,462	42,236	42,236
20	45,270	47,005	40,496	41,216	55,361	55,361	55,361	55,361	54,535	54,535	44,123	44,123
30	55,750	55,750	55,681	55,681	55,911	55,911	55,361	55,361	54,535	54,535	54,023	54,023
40	55,750	55,750	55,750	55,750	55,911	55,911	55,451	55,451	56,139	56,139	54,535	54,535
50	55,885	55,885	55,885	55,885	55,911	55,911	55,911	55,911	56,139	56,139	54,535	54,535
60	55,939	55,939	55,939	55,939	55,911	55,911	55,911	55,911	56,139	56,139	56,139	56,139
70	55,939	55,939	55,939	55,939	55,991	55,991	55,911	55,911	56,247	56,247	56,222	56,222
80	57,497	57,497	57,497	57,497	57,187	57,187	57,187	57,187	56,743	56,743	56,743	56,743
90	57,497	57,497	57,497	57,497	57,187	57,187	57,187	57,187	56,743	56,743	56,743	56,743
Max	57,497	57,497	57,497	57,497	57,187	57,187	57,187	57,187	56,743	56,743	56,743	56,743
Average	55,701	55,831	53,663	52,895	56,105	56,105	55,631	55,631	55,414	55,414	52,440	52,440
% Max WUA	95	95	91	90	95	95	95	95	94	94	89	89
Change	—	130	-2,038	-2,806	—	0	-473	-473	—	0	-2,974	-2,974
% Change	—	0	-4	-5	—	0	-1	-1	—	0	-5	-5

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

Table 7-17c. Distribution of July–September Weighted Usable Area (WUA) Values for *O. mykiss* Juvenile Rearing on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	July				August				September			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	22,475	22,475	22,477	22,595	—	—	—	—
20	—	—	—	25,801	22,527	22,658	23,054	24,359	22,806	22,806	23,477	23,451
30	28,204	35,367	30,736	28,951	23,221	23,530	28,386	27,022	27,122	27,294	26,925	25,711
40	36,116	36,449	35,881	35,881	35,356	35,596	35,222	35,222	30,475	30,475	28,174	27,019
50	37,051	37,130	36,574	36,574	36,401	36,325	36,210	36,210	34,687	34,687	34,836	34,836
60	37,130	37,130	37,130	37,130	37,114	37,052	36,680	36,680	35,226	35,226	35,915	35,915
70	37,130	37,130	37,130	37,130	37,130	37,130	37,130	37,130	36,274	35,915	36,460	36,460
80	37,130	37,130	37,130	37,130	37,130	37,130	37,130	37,130	36,677	36,461	37,086	37,086
90	37,130	37,130	37,130	37,130	37,130	37,130	37,130	37,130	37,130	37,111	37,130	37,130
Max	37,225	37,225	37,381	37,381	37,378	37,378	37,407	37,407	37,322	37,322	37,385	37,385
Average	35,533	36,006	35,468	34,469	32,762	32,975	33,398	33,462	33,358	33,355	33,144	32,625
%MaxWUA	95	96	95	92	88	88	89	89	89	89	89	87
Change	—	473	-65	-1,064	—	213	636	700	—	-3	-214	-733
% Change	—	1	0	-3	—	1	2	2	—	0	-1	-2

Note: Table shows the percent of time that a WUA value of equal or lower value occurs.

LSJR Alternative 2 (Less than significant)

Spawning

Under LSJR Alternative 2, spawning habitat availability for Chinook salmon, steelhead, and other fish species on the Stanislaus, Tuolumne, and Merced Rivers would remain unchanged or increase compared to baseline conditions. Adverse impacts would be less than significant.

Chinook Salmon Spawning

Under LSJR Alternative 2, modeled flows and associated WUA values indicate that there would be little or no change in the availability of spawning habitat for Chinook salmon relative to baseline conditions on the three eastside tributaries (Tables 7-11a, 7-11b, and 7-11c). Therefore, adverse impacts would be less than significant.

Steelhead Spawning

In the Tuolumne River, average WUA values for steelhead spawning would remain unchanged in January and increase by 6 percent in February and 10 percent in March compared to baseline conditions (Table 7-12a). In the Merced River, little or no change in steelhead spawning habitat availability is predicted to occur (Table 7-12b). Therefore, adverse impacts would be less than significant.

Other Fish Species (Spawning)

Based on the relatively small changes in Chinook salmon and steelhead spawning habitat under LSJR Alternative 2, no major changes in habitat availability for other native and nonnative species in the Stanislaus, Tuolumne, and Merced Rivers are expected. Therefore, adverse impacts would be less than significant.

Juvenile Rearing

Under LSJR Alternative 2, no substantial changes are expected in the quantity and quality of Chinook salmon and steelhead fry and juvenile rearing in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR compared to baseline conditions. Fry and juvenile rearing habitat for Chinook salmon on the Stanislaus River or LSJR would remain unchanged. While WUA for Chinook salmon fry and juvenile rearing would decrease in the Tuolumne and Merced Rivers, floodplain habitat would increase and water temperatures would decrease in response to higher spring flows. Therefore, adverse impacts would be less than significant.

Chinook Salmon Rearing

Under LSJR Alternative 2, modeled Stanislaus River flows (i.e., Goodwin Dam releases) during the Chinook salmon fry and juvenile rearing period (January–May) frequently fell outside the range of flows that could be evaluated using the WUA-discharge relationship (250–1,500 cfs). However, for those years in which flows were within this range, no substantial changes were evident in the magnitude of WUA values compared to baseline conditions (Tables 7-13a and 7-14a). In the Tuolumne River, increases in flows would reduce average WUA for fry and juvenile rearing by 6–10 percent in February–May (Tables 7-13b and 7-14b) but would increase the frequency of floodplain inundation events of 50 acres or more by approximately 20 percent in May (Table 7-15b) and decrease average water temperatures at the confluence by 1.7°F in May (Table 7-22b in Impact

AQUA-4). In the Merced River, increases in flows would primarily affect juvenile rearing habitat in May by reducing average WUA by 18 percent (Table 7-14c). However, overall increases in flow in May were accompanied by an average decrease in water temperature of 2.1°F at the confluence of the Merced (Table 7-22c), representing an overall improvement in habitat quality throughout the river. In addition, higher flows in the LSJR in May would increase the frequency of floodplain inundation events of 50 acres by 10 percent (Table 7-15d). Overall, the quantity and quality of rearing habitat for Chinook salmon fry and juvenile salmon, as measured by WUA, floodplain inundation area, and water temperature, would not change substantially relative to baseline conditions. Therefore, flow-related impacts on the quantity and quality of Chinook salmon rearing habitat would be less than significant.

Steelhead Rearing

Under LSJR Alternative 2, no substantial differences were evident in the magnitude of WUA values for steelhead fry and juvenile rearing compared to baseline conditions (Tables 7-16a, 7-16b, 7-16c, and 7-17a, 7-17b, and 7-17c). Therefore, adverse impacts would be less than significant.

Other Fish Species (Rearing)

Based on the conclusions above for Chinook salmon and steelhead juvenile rearing habitat, no major changes in habitat availability for other native and nonnative species in the Stanislaus, Tuolumne, and Merced Rivers are expected. Therefore, adverse impacts would be less than significant.

LSJR Alternative 3 (Less than significant)

Spawning

Under LSJR Alternative 3, the quantity and/or quality of spawning habitat for Chinook salmon, steelhead, and other fish species in the Stanislaus, Tuolumne, and Merced Rivers would be improved relative to baseline conditions. Negative impacts on the quantity and quality of spawning habitat would be less than significant.

Chinook Salmon Spawning

Under LSJR Alternative 3, average WUA values for Chinook salmon spawning in the Stanislaus River would decrease by 37 percent in October and remain unchanged in November and December relative to baseline conditions (Table 7-11a). Reductions in average WUA of 8–14 percent are also predicted to occur in the Tuolumne and Merced Rivers in October and November (Tables 7-11b and 7-11c). However, these reductions are associated with higher flows, which are expected to improve flow and temperature conditions for attraction, migration, and spawning (see Impact AQUA-4, LSJR Alternative 3) and potentially increase the longitudinal extent of suitable spawning habitat below the dams. Additionally, it is important to note that WUA for this life-stage does not take into account a number of other benefits associated with higher flows, including improved substrate (e.g., mobilization of fine sediment) and hyporheic (e.g., DO in redds) conditions. Finally, analyses of juvenile and adult production in relation to fall flows suggest that spawning habitat is not a major limiting factor for Chinook salmon populations in the LSJR tributaries (Mesick et al. 2007). Therefore, flow-related impacts on Chinook salmon spawning habitat would not have a significant adverse impact on Chinook salmon populations in the Stanislaus, Tuolumne, and Merced Rivers.

Steelhead Spawning

Under LSJR Alternative 3, average WUA values for steelhead spawning in the Tuolumne River would decrease by 1 percent in January, 17 percent in February, and 24 percent in March (Table 7-12a). In the Merced River, only slight changes would occur in spawning WUA relative to baseline conditions (Table 7-12b). Therefore, flow-related impacts on steelhead spawning habitat availability in the Stanislaus, Tuolumne, and Merced Rivers would be less than significant.

Other Fish Species (Spawning)

Under LSJR Alternative 3, increases in magnitude of spring flows in the Stanislaus, Tuolumne, and Merced Rivers and associated increases in floodplain habitat availability and decreases in water temperatures would benefit other (non-salmonid) native species and negatively affect nonnative species such as largemouth bass and other warmwater species that prey on or compete with native fishes. Based on reported changes in the abundance and distribution of native and nonnative resident species in the Tuolumne River and other Central Valley streams, higher spring flows and cooler water temperatures that mimic the natural flow regime provide more appropriate spawning conditions for native species (Brown and Ford 2002). Potential mechanisms include increases in water velocity that benefit native resident species that spawn in high-velocity habitats (e.g., riffle spawners such as Sacramento sucker, Sacramento pikeminnow, and riffle sculpin) and negatively affect nonnative species that spawn in low-velocity habitats (e.g., largemouth bass) (Brown and Ford 2002; Kiernan et al. 2012).

Increases in spring flows will also improve spawning conditions for splittail, sturgeon, striped bass, and other fishes, as well as improve water quality (e.g., water temperature and salinity) in the Stanislaus, Tuolumne, and Merced Rivers and in the LSJR (see Impact AQUA-4, LSJR Alternative 3). Therefore, LSJR Alternative 3 would have beneficial effects on other native fishes in the Stanislaus, Tuolumne and Merced Rivers and LSJR.

Juvenile Rearing

Under LSJR Alternative 3, fry and juvenile rearing conditions for Chinook salmon, steelhead, and other fish species in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would be substantially improved compared to baseline conditions. Therefore, adverse impacts would be less than significant.

Chinook Salmon Rearing

Under LSJR Alternative 3, no substantial differences are evident in the magnitude of WUA values for Chinook salmon fry and juvenile rearing in the Stanislaus River compared to baseline conditions (Tables 7-13a and 7-14a). Flows exceeding the range of the WUA-discharge relationship (250–1,500 cfs) would increase in frequency, increasing potential floodplain rearing opportunities for juvenile salmon under this alternative. In April and May, floodplain inundation events of 50 acres or more in the Stanislaus River are predicted to increase by approximately 10–20, corresponding to average increases in floodplain inundation area of 6 acres in April and 56 acres in May (Table 7-15a).

In the Tuolumne River, average WUA values for Chinook salmon rearing are predicted to decrease by 17 percent in February and 25 percent in March (fry rearing) and by 14 percent in April and May (juvenile rearing) compared to baseline conditions (Tables 7-13b and 7-14b). During these months, floodplain inundation events of 50 acres or more are predicted to decrease in frequency by approximately 10 percent in March and increase in frequency by 30 percent in April and

60 percent in May (Table 7-15b). These changes correspond to a decrease in average floodplain inundation area of 60 acres in March and increases in average floodplain inundation areas of 57 acres in April and 269 acres in May. Although habitat availability for fry would decrease in March, the capacity of the river for juvenile rearing would increase in April and May in response to higher spring flows, cooler water temperatures, and greater floodplain rearing opportunities. Higher spring flows and associated reductions in water temperatures are expected to increase the downstream extent and duration of suitable rearing temperatures throughout the river in many years (see Impact AQUA-4, LSJR Alternative 3). Overall, improvements in water temperatures and floodplain habitat availability later in the season (April and May) would likely enhance juvenile growth and survival, potentially increasing the number of juveniles that successfully emigrate from the river as smolts.

In the Merced River, LSJR Alternative 3 would not substantially affect Chinook salmon fry habitat availability in January–March as measured by WUA (Table 7-13c). During the juvenile rearing season (April–May), average WUA values are predicted to decrease by 21 percent in April and 25 percent in May compared to baseline conditions (Table 7-14c). However, similar to the Tuolumne River, LSJR Alternative 3 would result in substantial increases in the frequency and magnitude of floodplain inundation in April and May. Over the 82-year modeling period, the frequency of floodplain inundation events of 50 acres or more would increase in frequency by 10 percent in April and 50 percent in May, corresponding to increases in average floodplain inundation areas of 11 acres in April and 71 acres in May (Table 7-15c). Increases in floodplain rearing opportunities in April and May would also be accompanied by reductions in water temperatures throughout the Merced River (see Impact AQUA-4, LSJR Alternative 3). Overall, this alternative is expected to increase juvenile salmon production in the Stanislaus, Tuolumne, and Merced Rivers.

Under LSJR Alternative 3, higher flow contributions from the tributaries are also expected to increase the availability of floodplain habitat in the LSJR for juvenile Chinook salmon that leave the tributaries as fry or juveniles. Over the 82-year modeling period, the frequency of floodplain inundation events of 50 acres or more would increase by approximately 20 percent in April and May, corresponding to increases in average floodplain inundation areas of 39 acres in April and 137 acres in May (Table 7-15d).

Steelhead Rearing

Under LSJR Alternative 3, no substantial changes would occur in steelhead fry and juvenile rearing habitat availability (as measured by WUA) in the Stanislaus, Tuolumne, and Merced Rivers during the spring and summer rearing periods (Tables 7-16a, 7-16b, 7-17a, and 7-17b). However, steelhead fry and juveniles would benefit from increases in floodplain habitat availability and decreases in water temperatures in April and May as described for Chinook salmon. Therefore, flow-related adverse impacts on steelhead rearing habitat availability in the Stanislaus, Tuolumne, and Merced Rivers would be less than significant.

Other Fish Species (Rearing)

As discussed above under spawning, increases in spring flows will also improve rearing conditions for splittail, sturgeon, striped bass, and other fishes, as well as improve water quality (e.g., water temperature and salinity) in the Stanislaus, Tuolumne, and Merced Rivers, and in the LSJR and the Delta (See Impact AQUA-4, LSJR Alternative 3). For example, increases in the frequency, magnitude, and duration of spring floodplain inundation could enhance spawning and rearing success of migratory species such as Sacramento splittail that depend on relatively long periods of seasonal floodplain inundation to achieve strong year classes (Sommer et al. 2001). Therefore, LSJR Alternative 3 would have beneficial effects on other native fishes in the Stanislaus, Tuolumne, and Merced Rivers.

LSJR Alternative 4 (Less than significant)

Spawning

Under LSJR Alternative 4, suitable spawning habitat for Chinook salmon, steelhead, and other fish species in the Stanislaus, Tuolumne, and Merced Rivers would substantially improve compared to baseline conditions. Adverse impacts would be less than significant.

Chinook Salmon and Steelhead Spawning

Under LSJR Alternative 4, predicted changes in WUA values for Chinook salmon and steelhead spawning in the Stanislaus, Tuolumne, and Merced Rivers would be similar in magnitude to those predicted under LSJR Alternative 3 (Tables 7-11a, 7-11b, and 7-11c and 7-12a, 7-12b, and 7-12c). Therefore, flow-related impacts on Chinook salmon spawning habitat would not have a significant negative impact on Chinook salmon populations in the Stanislaus, Tuolumne, and Merced Rivers.

Other Fish Species (Spawning)

Under LSJR Alternative 4, further increases in the frequency, magnitude, and duration of spring flows compared to those occurring under LSJR Alternative 3 are expected to further increase the quantity and quality of habitat for native fish species and result in long-term increases in spawning success of other native fish species in the Stanislaus, Tuolumne, and Merced Rivers. The proposed flow regime, which is characterized by further increases in monthly modeled flows relative to LSJR Alternative 3, would further improve spawning conditions for splittail, sturgeon, striped bass, and other fishes, as well as improve water quality (e.g., water temperature and salinity) in the Stanislaus, Tuolumne, and Merced Rivers and in the LSJR and the Delta. Associated increases in the frequency, magnitude, and duration of floodplain inundation would further increase aquatic productivity (see Impact AQUA-9, LSJR Alternative 4) and the quantity of suitable spawning and rearing habitat for floodplain-dependent species such as Sacramento splittail. Similar to LSJR Alternative 3, this flow regime would also be expected to reduce the distribution and abundance of nonnative fishes as well as their negative impacts (e.g., predation) on other native fishes (see Impact AQUA-10, LSJR Alternative 4). Therefore, LSJR Alternative 4 would have beneficial effects on other native fishes in the Stanislaus, Tuolumne, and Merced Rivers.

Juvenile Rearing

Under LSJR Alternative 4, fry and juvenile rearing conditions for Chinook salmon, steelhead, and other fish species in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would be substantially improved compared to baseline conditions. Therefore, adverse impacts would be less than significant.

Chinook Salmon and Steelhead Rearing

Under LSJR Alternative 4, predicted changes in average WUA values for Chinook salmon and steelhead fry and juvenile rearing in the Stanislaus, Tuolumne, and Merced Rivers would be similar to those predicted under LSJR Alternative 3 (Tables 7-13a, 7-13b, 7-13c; 7-14a, 7-14b, 1-14c; 7-16a, 7-16b, 7-16c; and 7-17a, 7-17b, 7-17c). However, higher spring flows under this alternative would further increase the rearing capacity of these rivers by expanding the area of inundated floodplain habitat and downstream extent of suitable water temperatures especially in April and May (see Impact AQUA-4, Alternative LSJR 4). Over the 82-year modeling period, the frequency of floodplain inundation events of 50 acres or more in the Stanislaus, Tuolumne, and Merced Rivers would increase by 20–50 percent in April and 40–70 percent in May, corresponding to increases in average floodplain inundation areas of 68–179 acres in April and 176–484 acres in May (Tables 7-15a, 7-15b, and 7-15c). Therefore, LSJR Alternative 4 would substantially improve rearing conditions for Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers.

Under LSJR Alternative 4, higher spring flows in the LSJR relative to LSJR Alternative 3 would further increase the availability of floodplain habitat for juvenile Chinook salmon that leave the tributaries as fry or juveniles. Over the 82-year modeling period, floodplain inundation area under LSJR Alternative 4 would increase by 123 acres in April and 352 acres in May compared to baseline conditions (Table 7-16d).

Other Fish Species (Rearing)

As discussed for spawning, LSJR Alternative 4 would further increase the frequency, magnitude, and duration of spring flows compared to LSJR Alternative 3. The resulting increases in the quantity and quality of habitat for native fish species would result in long-term increases in rearing success of other native fish species in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Therefore, LSJR Alternative 4 would have beneficial effects on other native fishes in the three eastside tributaries and the LSJR.

Impact AQUA-4: Changes in exposure of fish to suboptimal water temperatures resulting from changes in reservoir storage and releases

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

The LSJR alternatives would affect river temperatures through changes in reservoir storage and flow on the three eastside tributaries and in the LSJR; this would affect the extent of suitable water temperatures for Chinook salmon and steelhead in the river environment below the dams.
The following assessment focuses on potential impacts of the alternatives on Chinook salmon and steelhead populations because of their sensitivity to water temperature, which is a flow-related variable, and their utility as key indicators of the responses of other native fish species to altered flow regimes in regulated rivers. Where appropriate, the Chinook salmon and steelhead analyses are combined. As previously discussed in Section 7.4.2, *Methods and Approach*, the results of this assessment are considered indicative of effects on other fish species; however, a general discussion of the potential responses of other fish species to the proposed alternatives is provided below.

The suitability of water temperatures for fish can generally be defined by optimal, suboptimal, and lethal ranges based on the chronic and acute responses of fish to thermal stress under laboratory and field conditions. Optimal water temperatures are those that cause no significant impacts, suboptimal temperatures are associated with chronic effects and cause increasing thermal stress as water temperatures approach lethal levels, and lethal temperatures are those that cause acute effects (e.g., severe impairment or death). The duration of exposure to suboptimal and lethal temperatures must also be considered in determining the potential for significant impacts.

Changes in water temperatures in the three eastside tributaries and mainstem LSJR associated with each of the LSJR alternatives were evaluated using the CALFED temperature model described in Section 7.4.2, *Methods and Approach* (CALFED 2009). The temperature thresholds used in this analysis are based on the U.S. Environmental Protection Agency's (USEPA's) recommended temperature criteria for protection of salmonids (USEPA 2003). The recommended metric for these criteria is the 7-day average of the daily maximum (7DADM). This metric is recommended because it describes maximum temperatures in a stream but is not overly influenced by the maximum temperature of a single day. Thus, it reflects an average of maximum temperatures that fish are exposed to over weekly periods. Since this metric is based on daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions, and can also be used to protect against sublethal or chronic effects such as temperature effects on growth, disease, smoltification, and competition (USEPA 2003).

USEPA's recommended criteria were used to define the upper limits of the optimal temperature ranges for adult migration, spawning and incubation, juvenile rearing, smolt outmigration, and summer rearing (Tables 7-18 and 7-19). These criteria serve as benchmarks to evaluate the frequency with which water temperatures exceed optimum water temperatures and potentially result in adverse chronic or acute effects on specific life stages. Predicted changes in exposure of Chinook salmon and steelhead to suboptimal water temperatures were evaluated by comparing the frequency and magnitude of 7DADM values (calculated as a running average of 7-day maximum daily temperatures during the modeled 1970–2003 period) under modeled baseline conditions and the LSJR alternatives. Significant impacts were identified based on changes of 10 percent or more in the frequency of water temperatures exceeding the USEPA criteria, and/or changes in average 7DADM water temperature of 1°F or more. These thresholds in combination with consideration of the potential exposure of Chinook and steelhead populations to suboptimal water temperatures at key locations and months (Tables 7-18 and 7-19) were used to determine whether impacts are significant. Due to lack of quantitative relationships between a given change in environmental conditions and relevant population metrics (e.g., survival or abundance), 10 percent was selected because that value is assumed to be high enough to reveal significant change to a condition while a lessor amount of change could be due to error in the various analytical and modeling techniques. Therefore, 10 percent provides a conservative qualitative basis to evaluate whether adverse effects to sensitive species at the population level will occur.

Table 7-18 and Table 7-19 summarize the water temperature criteria and the primary locations and months that were used to evaluate potential temperature impacts on Chinook salmon and steelhead life stages. The primary evaluation locations and months are based on the general distribution, abundance, and timing of each life stage in the eastside tributaries and LSJR. For example, water temperatures at locations approximately three-quarters of the distance from the mouth of each tributary to the first impassable dam were used to characterize water temperatures in the primary Chinook salmon and steelhead spawning reaches. This location was selected because it generally represents conditions in the majority of the spawning reaches and, therefore, reflects changes in both the downstream extent and quality of suitable water temperatures for spawning and incubation.

Table 7-18. Water Temperature Thresholds and Primary Locations and Months Used to Evaluate Potential Temperature Impacts on Chinook Salmon and Steelhead Life Stages in the Eastside Tributaries

Evaluation Time Period	Primary Life Stage (fall-run Chinook and steelhead)	Temperature Evaluation Thresholds (°C)	Temperature Evaluation Thresholds (°F)	Primary Evaluation Locations
September–October	Adult Migration	18 (7DADM)	64.4 (7DADM)	Confluence
October–March	Spawning and Incubation	13 (7DADM)	55.4 (7DADM)	¾ River
March–May	Juvenile Rearing (Chinook)	16 (7DADM)	60.8 (7DADM)	Confluence
April–June	Smoltification	14 (7DADM)	57.2 (7DADM)	Confluence
July–August	Summer Rearing (steelhead)	18 (7DADM)	64.4 (7DADM)	¾ River

Note: Each tributary was divided into quarters, with ¼, ½, and ¾ representing the fractional distances from the confluence to the first impassable dam.

Table 7-19. Water Temperature Thresholds and Primary Locations and Months Used to Evaluate Potential Temperature Impacts on Chinook Salmon and Steelhead Life Stages in the LSJR

Evaluation Time Period	Primary Life Stage (fall-run Chinook and steelhead composite)	Temperature Evaluation Thresholds (°C)	Temperature Evaluation Thresholds (°F)	Primary Evaluation Locations
September–October	Adult Migration	18 (7DADM)	64.4 (7DADM)	Vernalis
January–March	Juvenile Rearing	16 (7DADM)	60.8 (7DADM)	Vernalis
April–June	Smoltification	14 (7DADM)	57.2 (7DADM)	Vernalis

Although water temperature can affect DO levels, and both factors are related to apparent blockage and delays in migration of adult salmon in the Delta (see Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*), adverse effects associated with low DO levels have not been documented in other reaches of the SJR and its tributaries. Therefore, DO levels would remain within acceptable levels and potentially increase in response to higher flows and cooler temperatures under the LSJR alternatives.

Baseline

Water temperature is recognized as a primary stressor for Chinook salmon and steelhead in the SJR Basin. Exposure of these species to elevated water temperatures can cause thermal stress and lead to reductions in survival through a number of direct and indirect effects. These effects can be generally characterized as: (1) chronic effects related to changes in growth, disease resistance, swimming performance, and other biological functions over relatively long periods; and (2) acute effects related to the thermal tolerance of fish to lethal temperatures over relatively short periods (Sullivan et al. 2000). Water temperatures in the LSJR are typically in equilibrium with air temperatures during the hottest summer months. In the spring and fall, LSJR temperatures are influenced to some extent by inflows and water temperatures from the three eastside tributaries.

Reservoir operations can lead to elevated water temperatures in the spring, which have been identified as a major factor contributing to reduced survival and abundance of juveniles and subsequent returns of spawning adults to the LSJR and the three eastside tributaries. Excessively warm summer temperatures in the tributaries act to limit steelhead abundance by restricting suitable summer rearing habitat to the cooler uppermost reaches of accessible habitat immediately downstream of the rim dams. Consequently, the amount of suitable habitat may be insufficient to sustain healthy steelhead populations (CDFG 2007).

Modeled baseline temperatures and associated habitat conditions for the indicator species and their key life stages are summarized in text below. Modeled baseline temperature conditions are summarized in Tables 7-20a–7-20d through Tables 7-24a–7-24d for each river. These tables also provide a summary of expected temperatures under the LSJR alternatives.

Adult Migration

Potential exposure of adult salmon and steelhead to suboptimal water temperatures during their upstream migration was evaluated based on modeled September and October water temperatures in the SJR at Vernalis and at the mouths of the Stanislaus, Tuolumne, and Merced Rivers. Upstream migration of adult salmon into the SJR and its tributaries generally begins in September, although most of the run enters after September, with peak migration typically occurring in late October and early November following the onset of declining fall temperatures and managed pulse flows (CFS 2007a; CDFG 2001; CDFG 2002). It is assumed that adult steelhead also begin their upstream migration into the tributaries in early fall, with most migration occurring in late fall and winter. The USEPA criteria for salmon and trout migration (64.4°F 7DADM) was used to define the upper limit of the optimal temperature range for adult migration.

Under modeled baseline conditions, suitable water temperatures for adult migration in the SJR and eastside tributaries typically do not occur until October. In the Stanislaus River, 7DADM water temperatures exceeding 64.4°F at the mouth of the Stanislaus River occurred approximately 90 percent of the time in September and 20 percent of the time in October, and average 7DADM water temperatures were 69.6°F and 62.0°F, respectively (Table 7-20a). Water temperatures in the Tuolumne and Merced Rivers in September and October were generally warmer; 7DADM water temperatures exceeding 64.4°F at the mouths of the Tuolumne and Merced Rivers occurred approximately 90 percent of the time in September and 60-70 percent of the time in October (Tables 7-20b and 7-20c). Modeled 7DADM water temperatures in September and October averaged 75.5°F and 67.5°F in the Tuolumne River and 72.2°F and 65.9°F in the Merced River. At Vernalis, 7DADM water temperatures exceeding 64.4°F occurred approximately 90 percent of the time in September and 50 percent of the time in October (Table 7-20d). Average 7DADM temperatures were 72.4°F in September and 64.8°F in October.

Table 7-20a. Distribution of September–-October 7DADM Water Temperatures in Relation to USEPA Criteria for Salmon and Steelhead Adult Migration (64.4˚ F) at the Confluence of the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	September				October			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	55.3	55.4	57.4	57.5	53.3	53.5	54.5	55.0
10	64.5	64.7	64.2	64.7	57.4	57.4	57.1	57.4
20	67.4	67.2	65.5	65.9	58.2	58.1	57.8	58.1
30	68.4	68.3	67.2	67.5	59.0	58.9	58.4	58.9
40	69.3	69.1	68.6	69.0	60.0	59.8	59.2	59.5
50	70.0	69.8	69.5	69.9	61.2	60.8	60.1	60.3
60	70.9	70.6	70.5	70.7	62.8	61.8	61.0	61.2
70	71.7	71.5	71.5	71.8	64.2	63.0	62.1	62.3
80	73.1	72.6	72.7	72.9	66.1	64.7	63.7	64.0
90	74.3	73.9	73.8	74.0	68.2	67.0	66.2	66.4
Max	77.9	77.1	77.1	77.2	73.7	72.9	72.9	72.9
Avg	69.6	69.3	69.1	69.4	62.0	61.4	60.9	61.1
Change		-0.2	-0.5	-0.1		-0.6	-1.2	-0.9

Notes: Table shows the percent of time that a temperature of equal or lower value occurs.
Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-20b. Distribution of September–-October 7DADM Water Temperatures in Relations to USEPA Criteria for Salmon and Steelhead Adult Migration (64.4˚ F) at the Confluence of the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	September				October			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	59.6	59.6	59.6	59.6	56.2	56.2	56.6	56.6
10	70.7	70.7	67.4	67.6	61.9	61.9	61.4	61.5
20	72.8	72.8	69.7	69.8	63.7	63.7	62.9	63.2
30	74.0	74.0	72.4	72.4	64.9	64.9	64.2	64.3
40	75.0	75.0	73.7	73.9	65.9	65.9	65.5	65.5
50	76.1	76.1	75.3	75.3	67.1	67.1	66.4	66.6
60	77.0	77.0	76.7	76.7	68.6	68.6	67.7	67.8
70	77.9	77.9	77.6	77.7	70.3	70.3	69.5	69.5
80	78.8	78.8	78.5	78.6	71.6	71.6	71.1	71.2
90	80.1	80.1	80.1	80.1	73.6	73.6	73.1	73.2
Max	83.8	83.8	83.8	83.8	78.1	78.1	78.1	78.1
Avg	75.5	75.5	74.4	74.5	67.5	67.5	67.0	67.0
Change		0.0	-1.1	-1.0		0.0	-0.5	-0.5

Notes: Table shows the percent of time that a temperature of equal or lower value occurs.
Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-20c. Distribution of September–-October 7DADM Water Temperatures in Relation to USEPA Criteria for Salmon and Steelhead Adult Migration (64.4˚ F) at the Confluence of the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	September				October			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	62.2	62.2	62.2	62.2	57.4	57.4	57.5	57.9
10	67.0	67.0	66.9	67.3	61.4	61.4	61.2	61.3
20	69.0	69.0	68.7	68.9	62.7	62.5	62.2	62.2
30	70.1	70.0	70.1	70.0	63.5	63.3	63.0	63.0
40	71.3	71.3	71.3	71.3	64.5	64.2	63.8	63.9
50	72.8	72.7	72.7	72.6	65.5	64.9	64.7	64.8
60	73.9	73.8	73.8	73.9	66.6	65.9	65.7	66.1
70	74.8	74.8	74.6	74.7	67.8	67.1	66.7	67.2
80	75.5	75.5	75.4	75.5	68.9	68.3	68.0	68.5
90	76.8	76.7	76.8	76.8	70.9	70.3	70.4	70.9
Max	80.6	80.4	80.5	80.6	75.0	74.9	74.9	75.1
Avg	72.2	72.2	72.1	72.2	65.9	65.5	65.2	65.5
Change		0.0	-0.1	0.0		-0.4	-0.7	-0.4

Notes: Table shows the percent of time that a temperature of equal or lower value occurs.
Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-20d. Distribution of September–-October 7DADM Water Temperatures in Relation to USEPA Criteria for Salmon and Steelhead Adult Migration (64.4˚ F) in the San Joaquin River at Vernalis under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	September				October			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	59.5	59.5	62.2	62.3	56.1	56.1	56.5	56.6
10	68.3	68.2	67.5	67.9	60.3	60.2	60.0	60.2
20	70.2	70.1	69.6	69.8	61.2	61.2	60.9	61.1
30	71.0	70.9	70.5	70.7	62.4	62.1	61.7	61.9
40	72.0	72.0	71.4	71.7	63.5	63.1	62.5	62.7
50	73.0	73.0	72.5	72.6	64.4	64.0	63.3	63.5
60	73.8	73.7	73.5	73.6	65.5	65.0	64.4	64.6
70	74.3	74.2	74.1	74.2	66.8	66.4	65.7	65.9
80	75.0	75.0	75.0	75.0	68.3	67.9	67.0	67.1
90	75.9	75.8	75.9	75.9	70.3	69.9	69.3	69.5
Max	79.3	79.0	79.0	79.0	74.0	73.8	73.8	73.8
Avg	72.4	72.3	72.1	72.2	64.8	64.5	64.0	64.1
Change		-0.1	-0.3	-0.1		-0.3	-0.8	-0.6

Notes: Table shows the percent of time that a temperature of equal or lower value occurs.

▨ Gray shading indicates temperatures that exceed USEPA criteria.

Spawning and Incubation

Potential exposure of Chinook salmon and steelhead spawning and incubation life stages to suboptimal water temperatures was evaluated based on modeled water temperatures at RM 43.7 on the Stanislaus River, RM 38.3 on the Tuolumne River, and RM 37.8 on the Merced River. These stations are located approximately three-quarters of the distance from the mouth of each tributary to the first impassable dam, and generally characterize water temperatures in the primary Chinook salmon and steelhead spawning reaches. Chinook salmon spawning and incubation generally extends from October–March while steelhead spawning and incubation extends from January–March.

Under modeled baseline conditions, suitable water temperatures for Chinook salmon spawning and incubation in the Stanislaus, Tuolumne, and Merced Rivers generally do not occur until early to late November in most years. In the Stanislaus River, 7DADM temperatures exceeding the USEPA criterion for salmon and trout spawning (55.4°F) occurred approximately 80 percent of the time in October and over 50 percent of the time in November (Table 7-21a). Water temperatures generally decline in October and November, reach annual lows (typically less than 55.4°F) from December–February, and begin increasing in February and March. The same general pattern is observed in the Tuolumne and Merced Rivers although modeled water temperatures at comparable locations downstream of the dams are typically warmer than those on the Stanislaus River (Tables 7-21b and 7-21c).

Under modeled baseline conditions, water temperatures in the Stanislaus, Tuolumne, and Merced Rivers are nearly always suitable for steelhead spawning and incubation in January (Table 7-21a, 7-21b, and 7-21c). Water temperatures exceeding the USEPA spawning and incubation criterion (55.4°F) begin to increase in frequency in February and occur approximately 20 percent of the time in the Stanislaus River, 40 percent of the time in the Tuolumne River, and 70 percent of the time in the Merced River by March (Tables 7-21a, 7-21b, and 7-21c).

Table 7-21a. Distribution of October–March 7DADM Water Temperatures in Relation to USEPA Criteria for Salmonid Spawning, Egg Incubation, and Fry Emergence (55.4˚F) at RM 43.7 on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	October					November					December			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	51.5	51.7	52.4	53.3	Min	49.4	49.6	49.7	50.9	Min	47.4	47.4	47.3	46.6
10	54.8	54.9	54.7	55.1	10	53.1	53.0	53.2	53.5	10	49.0	49.1	49.1	49.2
20	55.6	55.6	55.5	56.0	20	53.9	54.0	54.1	54.4	20	49.9	49.7	49.7	50.0
30	56.3	56.1	55.9	56.4	30	54.6	54.5	54.5	54.8	30	50.5	50.4	50.5	50.6
40	56.9	56.8	56.7	57.1	40	55.1	54.9	55.0	55.3	40	51.1	50.9	51.0	51.1
50	57.6	57.5	57.3	57.7	50	55.6	55.3	55.5	55.7	50	51.7	51.5	51.6	51.7
60	58.4	58.1	57.8	58.1	60	56.3	55.8	56.0	56.1	60	52.2	52.0	52.1	52.3
70	59.8	58.9	58.6	58.7	70	57.0	56.4	56.5	56.7	70	52.8	52.5	52.6	52.8
80	61.3	59.7	59.3	59.6	80	58.1	57.2	57.2	57.3	80	53.3	53.1	53.2	53.3
90	66.1	60.9	60.5	60.9	90	60.2	58.2	58.1	58.2	90	54.5	53.8	53.9	54.0
Max	70.7	66.2	66.3	66.7	Max	65.9	60.6	60.2	60.7	Max	58.8	55.7	55.6	56.1
Avg	58.7	57.7	57.5	57.9	Avg	56.2	55.5	55.5	55.8	Avg	51.8	51.5	51.5	51.6
Change		-1.0	-1.2	-0.8			-0.7	-0.7	-0.4			-0.3	-0.3	-0.1

	January					February					March			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	45.3	45.3	45.2	45.2	Min	45.6	45.3	45.3	45.4	Min	48.4	48.8	48.7	48.7
10	47.4	47.4	47.4	47.4	10	48.5	48.3	48.1	48.0	10	50.3	50.3	50.2	49.9
20	48.2	48.2	48.3	48.3	20	49.1	49.1	48.8	48.6	20	51.2	50.8	50.9	50.5
30	48.7	48.8	48.8	48.8	30	49.6	49.4	49.2	49.1	30	51.9	51.5	51.6	51.1
40	49.2	49.2	49.2	49.3	40	50.1	49.9	49.6	49.5	40	52.6	52.2	52.0	51.6
50	49.6	49.5	49.6	49.6	50	50.6	50.4	50.2	49.9	50	53.2	53.0	52.6	52.3
60	50.0	49.9	49.9	49.9	60	51.1	51.0	50.8	50.6	60	53.9	53.9	53.3	52.8
70	50.4	50.3	50.3	50.4	70	51.6	51.5	51.4	51.2	70	54.6	54.6	54.1	53.5
80	50.9	50.7	50.7	50.8	80	52.2	52.1	51.9	51.7	80	55.5	55.6	54.7	54.0
90	51.7	51.5	51.6	51.6	90	53.2	53.2	53.0	52.5	90	56.5	56.8	55.5	54.7
Max	53.6	53.5	53.5	53.6	Max	55.6	56.0	55.7	55.1	Max	60.3	60.3	58.0	57.5
Avg	49.6	49.5	49.5	49.5	Avg	50.7	50.6	50.4	50.2	Avg	53.4	53.3	52.8	52.3
Change		-0.1	-0.1	0.0			-0.1	-0.3	-0.5			-0.1	-0.6	-1.0

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-21b. Distribution of October–March 7DADM Water Temperatures in Relation to USEPA Criteria for Salmonid Spawning, Egg Incubation, and Fry Emergence (55.4˚F) at RM 38.3 on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	October					November					December			
Percentile	Baseline	LSJR Alt2	LSJR Alt3	LSJR Alt4	Percentile	Baseline	LSJR Alt2	LSJR Alt3	LSJR Alt4	Percentile	Baseline	LSJR Alt2	LSJR Alt3	LSJR Alt4
Min	54.6	54.6	55.6	55.6	Min	51.6	51.9	51.9	51.5	Min	49.2	49.3	49.3	49.1
10	56.9	57.1	57.1	57.5	10	54.3	54.3	54.7	54.7	10	51.5	51.5	51.7	51.5
20	58.0	58.1	57.9	58.5	20	55.0	55.0	55.2	55.5	20	52.0	52.1	52.3	52.3
30	58.9	59.0	58.8	59.2	30	55.6	55.6	55.7	55.9	30	52.5	52.5	52.7	52.8
40	59.9	60.0	59.5	59.7	40	55.9	55.9	56.0	56.4	40	52.9	52.9	53.1	53.3
50	60.6	60.6	60.2	60.2	50	56.4	56.4	56.5	56.7	50	53.3	53.3	53.4	53.6
60	61.7	61.7	61.2	61.3	60	57.1	57.1	57.0	57.1	60	53.6	53.6	53.8	53.9
70	62.7	62.6	62.5	62.6	70	57.6	57.6	57.5	57.5	70	54.0	53.9	54.2	54.2
80	64.2	64.0	64.1	64.1	80	58.4	58.2	58.3	58.2	80	54.4	54.3	54.6	54.8
90	67.0	66.7	66.8	66.7	90	59.7	59.5	59.3	59.1	90	55.1	55.0	55.2	55.4
Max	74.1	74.0	74.0	74.0	Max	62.0	61.5	61.7	61.5	Max	57.8	57.5	57.6	57.5
Avg	61.3	61.3	61.2	61.3	Avg	56.7	56.6	56.7	56.8	Avg	53.3	53.3	53.5	53.5
Change		0.0	-0.1	0.0			0.0	0.0	0.1			0.0	0.2	0.2

	January					February					March			
Percentile	Baseline	LSJR Alt2	LSJR Alt3	LSJR Alt4	Percentile	Baseline	LSJR Alt2	LSJR Alt3	LSJR Alt4	Percentile	Baseline	LSJR Alt2	LSJR Alt3	LSJR Alt4
Min	48.4	48.4	48.4	48.3	Min	48.2	48.3	48.2	48.2	Min	48.7	48.7	48.7	48.6
10	50.2	50.2	50.5	50.4	10	49.8	49.8	49.7	49.7	10	50.0	50.1	50.0	49.9
20	50.9	51.0	51.1	51.0	20	50.3	50.3	50.4	50.0	20	50.5	50.7	50.7	50.4
30	51.4	51.5	51.5	51.5	30	51.1	51.1	51.1	50.4	30	51.0	51.2	51.1	50.8
40	51.8	51.9	51.9	52.0	40	52.0	51.9	51.7	51.4	40	51.6	51.9	51.6	51.3
50	52.2	52.2	52.3	52.4	50	53.2	52.8	52.4	51.9	50	53.0	52.9	52.5	51.8
60	52.5	52.6	52.8	52.8	60	54.1	53.6	53.1	52.4	60	56.2	54.2	53.6	52.7
70	53.0	53.1	53.2	53.3	70	54.7	54.4	53.9	53.3	70	57.5	56.2	54.4	53.2
80	53.5	53.5	53.7	53.8	80	55.5	55.3	54.6	53.8	80	58.7	57.4	55.3	54.1
90	54.1	54.1	54.3	54.3	90	56.7	56.8	55.5	55.0	90	60.6	58.6	56.5	55.3
Max	55.7	55.7	55.6	55.8	Max	60.1	60.1	59.8	59.8	Max	63.9	62.0	60.2	60.1
Avg	52.2	52.2	52.3	52.4	Avg	53.1	53.0	52.6	52.1	Avg	54.5	53.8	52.9	52.3
Change		0.0	0.2	0.2			-0.1	-0.5	-1.0			-0.8	-1.6	-2.2

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-21c. Distribution of October–March 7DADM Water Temperatures in Relation to USEPA Criteria for Salmonid Spawning, Egg Incubation, and Fry Emergence (55.4˚F) at RM 37.8 on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

October				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	57.5	57.5	57.6	57.6
10	60.4	60.3	60.2	60.4
20	61.4	61.3	61.0	61.2
30	62.3	62.2	62.0	62.1
40	63.2	62.7	62.7	62.8
50	64.0	63.5	63.2	63.5
60	64.9	64.2	63.9	64.3
70	66.5	65.0	64.8	65.3
80	68.4	66.1	66.2	67.3
90	70.9	68.5	68.5	70.5
Max	80.2	79.2	79.4	80.5
Avg	64.9	64.0	63.8	64.5
Change		-0.9	-1.0	-0.4

November				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	52.6	52.7	53.1	52.7
10	55.5	55.4	55.4	55.6
20	56.7	56.4	56.3	56.7
30	57.5	57.2	57.0	57.4
40	58.3	57.9	57.6	58.1
50	59.2	58.6	58.6	58.8
60	60.1	59.4	59.3	59.4
70	61.1	60.2	59.9	60.0
80	62.0	61.0	60.6	61.0
90	64.4	62.0	61.7	62.4
Max	68.8	64.4	64.5	68.8
Avg	59.6	58.7	58.5	59.0
		-0.9	-1.1	-0.6

December				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	48.9	48.9	48.7	48.5
10	50.7	50.7	50.7	50.8
20	51.5	51.4	51.5	51.6
30	52.1	52.0	52.1	52.3
40	52.7	52.6	52.7	52.8
50	53.3	53.1	53.1	53.3
60	53.7	53.5	53.6	53.8
70	54.5	54.1	54.1	54.4
80	55.3	54.8	54.7	54.9
90	56.7	55.4	55.5	55.9
Max	60.3	59.1	59.0	60.4
Avg	53.5	53.1	53.2	53.4
		-0.4	-0.3	-0.1

January				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	46.8	46.8	46.8	46.7
10	49.3	49.3	49.3	49.2
20	49.9	50.1	50.0	49.9
30	50.4	50.6	50.6	50.5
40	50.8	51.1	51.1	50.9
50	51.2	51.5	51.5	51.4
60	51.7	51.9	51.9	51.9
70	52.2	52.3	52.3	52.3
80	52.9	52.9	52.9	52.9
90	53.7	53.7	53.7	53.7
Max	56.8	56.9	57.0	56.9
Avg	51.4	51.5	51.5	51.4
Change		0.1	0.1	0.1

February				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	46.9	46.9	46.9	46.8
10	50.1	50.3	50.2	49.4
20	51.1	51.3	51.4	50.6
30	52.1	52.2	52.2	51.7
40	52.6	52.9	52.8	52.5
50	53.2	53.6	53.3	53.2
60	54.0	54.4	54.0	53.9
70	54.9	55.2	54.8	54.4
80	55.8	56.0	55.9	55.5
90	57.4	57.6	57.5	57.0
Max	60.8	61.2	61.2	61.1
Avg	53.5	53.7	53.6	53.2
		0.2	0.1	-0.3

March				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	48.5	48.5	48.5	48.5
10	51.6	51.4	51.2	50.8
20	53.9	53.9	53.8	53.2
30	55.5	55.7	55.2	54.2
40	56.5	56.7	56.1	55.2
50	57.5	57.7	57.0	56.1
60	58.3	58.5	57.7	56.9
70	59.0	59.2	58.5	57.6
80	59.9	60.1	59.3	58.5
90	61.0	61.2	60.3	59.5
Max	65.9	64.7	63.4	61.9
Avg	57.0	57.1	56.5	55.7
		0.1	-0.5	-1.3

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Juvenile Rearing

Potential exposure of Chinook salmon rearing life stages to suboptimal water temperatures was evaluated based on modeled water temperatures at the mouths of the Stanislaus, Tuolumne, and Merced Rivers. These stations were selected because juvenile salmon rearing in the tributaries may occur as far downstream as the tributary mouths following their emergence as fry in the winter and early spring (although some proportion of these fry migrate beyond the confluences to complete their freshwater rearing phases in the LSJR and/or Delta; see *LSJR* in Section 7.2.2. *Reservoirs, Tributaries, and LSJR*). Chinook salmon rearing in the tributaries generally occurs from January–May; however, the primary months of concern with respect to temperature are March–May. In contrast, the evaluation of potential water temperature effects on steelhead rearing focused on the summer months (July–August) at stations located three quarters of the distance from the confluence to the first impassable dam, which generally marks the downstream limit of summer rearing (CALFED 2009; NMFS 2009c).

Under modeled baseline conditions, exposure of juvenile salmon to suboptimal water temperatures (as defined by the USEPA criterion of 60.8°F) in the Stanislaus, Tuolumne, and Merced Rivers and LSJR increases through the spring. In the Stanislaus River, 7DADM water temperatures exceeding this threshold occurred 10 percent of the time in March, 20 percent of the time in April, and 40 percent of the time in May (Table 7-22a). Modeled 7DADM temperatures in these months averaged 56.5°F, 58.5°F, and 61.5°F, respectively. Higher water temperatures are predicted to occur in the Tuolumne and Merced Rivers. In the Tuolumne River, 7DADM water temperatures exceeding the USEPA criterion are predicted to occur approximately 30 percent of the time in March, 40 percent of the time in April, and 70 percent of the time in May (Table 7-22b). Modeled 7DADM water temperatures in these months averaged 58.5°F, 61.7°F, and 65.9°F. In the Merced River, 7DADM water temperatures exceeding the USEPA criterion are predicted to occur approximately 30 percent of the time in March, 70 percent of the time in April, and 90 percent of the time in May (Table 7-22c). Modeled 7DADM water temperatures in these months averaged 58.6°F, 64.0°F, and 68.2°F. In the SJR at Vernalis, 7DADM water temperatures exceeding the USEPA criterion are predicted to occur approximately 10 percent of the time in March, 50 percent of the time in April, and 90 percent of the time in May (Table 7-22d). Modeled 7DADM water temperatures in these months averaged 58.0°F, 61.6°F, and 65.7°F.

During the summer, juvenile steelhead frequently experience suboptimal water temperatures (as defined by the USEPA criterion of 64.4°F) in the Stanislaus, Tuolumne, and Merced Rivers under baseline conditions. In the Stanislaus River at RM 43.7, 7DADM water temperatures exceeding the USEPA criterion are predicted to occur approximately 50 percent of the time in July and August (Table 7-23a). Modeled 7DADM temperatures in these months averaged 64.8°F and 65.0°F, respectively. Higher water temperatures are predicted to occur at similar locations in the Tuolumne and Merced Rivers, exceeding the USEPA criterion 70 percent of the time in July and 80–90 percent of the time in August (Tables 7-23b and 7-23c). Modeled 7DADM temperatures in July and August averaged 69.8°F and 71.1°F in the Tuolumne River, and 73.3°F and 73.2°F in the Merced River.

Table 7-22a. Distribution of March–May 7DADM Water Temperatures in Relation to USEPA Criteria for Salmonid Juvenile Rearing (60.8˚F) at the Confluence of the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

March					April					May				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	49.5	49.6	49.5	49.5	Min	51.2	51.2	51.2	51.1	Min	54.3	54.3	54.3	53.7
10	52.2	52.1	52.1	51.7	10	54.7	54.9	54.9	54.2	10	57.6	57.9	57.4	56.2
20	53.7	53.1	53.1	52.5	20	55.7	55.9	55.8	55.1	20	58.7	59.1	58.4	57.1
30	54.8	54.1	54.0	53.2	30	56.6	56.7	56.5	55.9	30	59.5	59.8	59.0	57.6
40	55.7	55.2	54.9	54.1	40	57.3	57.4	57.2	56.7	40	60.0	60.4	59.5	58.1
50	56.4	56.3	55.8	54.9	50	58.1	58.1	57.9	57.3	50	60.7	60.9	60.1	59.0
60	57.2	57.3	56.4	55.7	60	58.9	59.1	58.7	58.1	60	61.5	61.6	60.9	59.7
70	58.0	58.2	57.2	56.4	70	59.9	60.0	59.6	58.9	70	62.7	62.7	61.8	60.6
80	59.3	59.4	58.2	57.3	80	61.2	61.6	60.7	59.6	80	64.7	64.0	62.9	61.8
90	60.6	60.9	59.8	58.4	90	63.1	63.2	61.7	60.7	90	66.4	66.2	65.0	64.2
Max	65.4	65.4	63.3	62.2	Max	67.1	66.9	66.3	66.2	Max	72.9	71.7	70.8	67.8
Avg	56.5	56.4	55.8	55.0	Avg	58.5	58.6	58.2	57.4	Avg	61.5	61.5	60.7	59.5
Change		-0.1	-0.7	-1.5			0.1	-0.3	-1.1			0.0	-0.8	-2.1

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-22b. Distribution of March–May 7DADM Water Temperatures in Relation to USEPA Criteria for Salmonid Juvenile Rearing (60.8˚F) at the Confluence of the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

March					April					May				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	51.7	51.7	51.7	51.6	Min	52.7	52.7	52.7	52.7	Min	55.7	55.7	55.6	55.6
10	53.0	53.1	53.2	53.0	10	55.5	55.6	55.3	54.9	10	59.4	59.2	58.1	57.8
20	53.9	54.2	54.3	53.9	20	56.9	56.9	56.6	55.9	20	61.0	60.8	58.9	58.8
30	54.8	55.0	55.1	54.5	30	58.0	58.0	57.5	56.8	30	62.3	61.7	59.6	59.3
40	55.8	56.0	55.9	55.0	40	59.3	59.4	58.3	57.4	40	63.6	62.5	60.2	59.8
50	57.4	57.4	56.8	55.7	50	60.7	60.8	59.2	57.7	50	65.4	63.6	60.7	60.4
60	59.6	58.9	57.9	56.6	60	62.6	62.3	59.8	58.2	60	67.3	64.7	61.1	61.1
70	61.5	60.5	59.3	57.8	70	65.1	63.5	60.7	58.8	70	69.4	66.3	61.9	61.7
80	63.2	62.3	60.5	58.7	80	66.9	64.9	61.5	59.4	80	71.1	67.9	63.1	62.3
90	65.5	64.1	61.8	60.0	90	69.0	66.5	62.9	60.5	90	73.2	70.2	65.2	63.2
Max	69.5	69.0	65.8	64.9	Max	74.0	73.5	71.4	67.7	Max	77.6	75.1	69.1	66.0
Avg	58.5	58.1	57.3	56.3	Avg	61.7	61.0	59.2	57.9	Avg	65.9	64.2	61.1	60.5
Change		-0.4	-1.2	-2.2			-0.7	-2.5	-3.8			-1.7	-4.8	-5.4

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-22c. Distribution of March–May 7DADM Water Temperatures in Relation to USEPA Criteria for Salmonid Juvenile Rearing (60.8˚F) at the Confluence of the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

Mar					Apr					May				
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	49.9	49.9	49.9	49.8	Min	52.1	52.1	52.2	52.2	Min	55.9	55.8	55.8	55.1
10	53.3	53.3	53.3	52.9	10	58.2	58.3	57.6	55.9	10	61.2	61.3	60.0	58.5
20	54.8	54.9	54.8	54.3	20	60.5	60.7	59.5	57.5	20	63.7	63.0	61.1	59.9
30	56.7	56.8	56.3	55.4	30	62.0	62.2	60.6	58.9	30	65.3	64.0	62.1	60.6
40	57.8	57.9	57.4	56.5	40	63.0	63.2	61.3	59.7	40	67.0	65.0	62.9	61.4
50	58.7	58.7	58.5	57.6	50	64.0	63.9	61.9	60.4	50	68.8	66.0	63.6	62.1
60	59.9	59.9	59.5	58.4	60	65.0	64.7	62.5	61.1	60	70.0	67.0	64.5	62.9
70	60.8	60.8	60.3	59.4	70	66.4	65.4	63.2	61.7	70	71.3	68.1	65.5	64.0
80	61.9	61.9	61.3	60.2	80	67.6	66.3	63.8	62.4	80	72.6	69.5	66.7	65.2
90	63.4	63.3	62.3	61.4	90	69.6	67.6	64.9	63.5	90	74.3	70.6	68.5	67.0
Max	66.7	66.9	65.5	64.0	Max	73.2	73.9	73.4	71.7	Max	78.1	75.2	72.2	71.5
Avg	58.6	58.6	58.1	57.3	Avg	64.0	63.5	61.7	60.2	Avg	68.2	66.1	63.9	62.5
Change		0.0	-0.4	-1.2			-0.5	-2.2	-3.8			-2.1	-4.3	-5.7

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-22d. Distribution of March–May 7DADM Water Temperatures in Relation to USEPA Criteria for Salmonid Juvenile Rearing (60.8˚F) in the San Joaquin River near Vernalis under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

March					April					May				
Mar	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Apr	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	May	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	53.0	53.0	53.0	52.8	Min	54.7	54.7	54.7	54.6	Min	59.6	59.8	58.8	57.8
10	54.5	54.4	54.5	54.5	10	58.0	58.1	57.8	57.6	10	61.7	61.8	60.8	60.2
20	55.4	55.4	55.5	55.2	20	59.1	59.3	59.1	58.4	20	63.1	63.1	61.7	61.0
30	56.2	56.5	56.3	55.8	30	59.9	60.0	59.8	59.0	30	64.0	63.9	62.4	61.4
40	57.0	57.2	57.0	56.5	40	60.7	60.8	60.3	59.6	40	64.6	64.5	63.0	62.0
50	57.8	57.8	57.6	57.1	50	61.5	61.6	61.0	60.1	50	65.3	65.1	63.7	62.7
60	58.5	58.6	58.3	57.7	60	62.2	62.3	61.6	60.6	60	66.2	65.8	64.2	63.3
70	59.4	59.5	59.1	58.4	70	63.1	63.1	62.2	61.0	70	67.1	66.5	65.1	64.0
80	60.5	60.6	60.1	59.2	80	63.9	63.8	62.8	61.7	80	68.4	67.5	66.0	64.8
90	61.9	62.1	61.1	60.3	90	65.5	65.3	63.7	62.6	90	69.9	69.0	67.4	66.0
Max	65.2	65.8	65.3	63.5	Max	69.9	68.8	69.3	68.3	Max	75.0	74.2	71.3	68.9
Avg	58.0	58.1	57.8	57.2	Avg	61.6	61.6	60.9	60.1	Avg	65.7	65.3	63.9	62.9
Change		0.1	-0.2	-0.8			0.0	-0.7	-1.5			-0.3	-1.8	-2.8

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-23a. Distribution of July–August 7DADM Water Temperatures in Relation to USEPA Criterion for Summer Rearing (64.4˚F) at RM 43.7 on the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	July				August			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LJR Alt 3	LSJR Alt 4
Min	53.6	53.6	53.8	53.2	54.7	54.7	55.0	57.0
10	59.6	59.7	59.4	59.0	60.2	61.0	61.5	61.3
20	62.1	62.5	60.2	60.0	62.9	62.8	62.7	62.9
30	63.6	63.3	61.4	61.1	63.6	63.5	63.3	63.8
40	64.2	64.0	62.9	62.8	64.1	63.9	63.9	64.4
50	65.0	64.8	64.1	64.2	64.6	64.4	64.5	65.1
60	65.7	65.6	65.3	65.8	65.5	65.2	65.4	66.2
70	66.7	66.3	66.6	66.9	66.5	66.1	66.5	67.2
80	68.3	67.6	67.7	67.9	68.2	67.3	67.4	67.8
90	69.4	68.9	68.8	69.1	70.3	68.6	68.5	68.7
Max	73.8	71.6	71.6	71.7	74.5	71.7	71.7	71.8
Avg	64.8	64.5	63.9	64.0	65.0	64.5	64.7	65.2
Change		-0.3	-0.9	-0.8		-0.6	-0.3	0.2

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-23b. Distribution of July–August 7DADM Water Temperatures in Relation to USEPA Criterion for Summer Rearing (64.4˚F) at RM 38.3 on the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	July				August			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	54.0	54.1	53.8	54.1	56.8	56.7	56.7	57.6
10	56.2	56.2	56.4	57.2	64.9	64.9	62.2	63.2
20	59.8	59.2	58.2	59.5	66.3	66.3	64.8	65.2
30	66.3	64.6	59.5	60.7	66.8	66.9	66.1	66.4
40	67.6	67.3	63.2	62.9	67.5	67.5	67.1	67.3
50	68.9	68.3	67.9	67.9	69.1	69.2	68.2	68.4
60	76.3	74.3	71.3	70.0	75.2	75.2	75.3	75.3
70	77.4	76.7	76.6	76.4	76.3	76.3	76.4	76.4
80	78.4	77.9	77.8	77.7	77.2	77.2	77.3	77.3
90	79.3	79.1	79.1	79.1	78.6	78.6	78.6	78.7
Max	82.6	82.6	82.6	82.6	82.1	82.1	82.1	82.2
Avg	69.8	69.0	67.9	68.2	71.1	71.1	70.7	70.9
Change		-0.8	-2.0	-1.7		0.0	-0.4	-0.2

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-23c. Distribution of July–August 7DADM Water Temperatures in Relation to USEPA Criterion for Summer Rearing (64.4˚F) at RM 37.8 on the Merced River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	July				August			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	56.3	56.3	56.3	57.0	60.2	60.2	60.2	60.3
10	60.0	60.0	60.4	62.0	63.8	63.9	64.1	65.0
20	62.8	63.1	64.9	66.6	64.5	64.5	65.0	66.6
30	74.0	67.9	68.1	68.1	65.7	66.0	67.9	67.9
40	75.9	75.1	71.4	70.6	74.3	74.4	73.9	74.3
50	76.6	76.2	75.2	75.3	75.6	75.5	75.3	75.7
60	77.3	77.2	76.6	76.8	76.5	76.5	76.2	76.6
70	78.0	77.9	77.5	77.8	77.8	77.7	77.7	78.1
80	79.1	78.9	78.7	79.1	79.1	78.7	78.8	79.5
90	81.3	80.6	80.7	81.3	80.7	80.3	80.6	81.3
Max	87.1	87.0	86.9	87.0	85.5	84.9	85.2	86.2
Avg	73.3	72.8	72.4	72.9	73.2	73.2	73.2	73.8
Change		-0.5	-0.9	-0.4		0.0	0.0	0.7

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Smoltification

Potential exposure of Chinook salmon and steelhead smolts to suboptimal water temperatures under baseline and alternative operational conditions was evaluated based on modeled water temperatures at the mouths of the Stanislaus, Tuolumne, and Merced Rivers and in the SJR at Vernalis during the spring outmigration period (April–June). These stations were selected because of the importance of suitable water temperatures for smolt development and health prior to their transition from fresh to saltwater. The following analysis examines differences in exposure of salmon and steelhead smolts to suboptimal water temperatures based on the frequency of modeled 7DADM temperatures that exceed the recommended USEPA criterion of 57.2°F for steelhead smoltification. Steelhead smolts are considered the most temperature-sensitive species and life stage during the spring outmigration period.

Under modeled baseline conditions, spring water temperatures frequently exceed the USEPA criterion for smoltification at the mouths of the Stanislaus, Tuolumne, and Merced Rivers and in the LSJR. Modeled 7DADM water temperatures exceeding the USEPA criterion are predicted to occur 60–90 percent of the time in April, 90 percent of the time in May, and nearly 100 percent of the time in June (Tables 7-24a, 7-24b, and 7-24c). Average 7DADM temperatures ranged from 58.5°F–64.0°F in April, 61.5°F–68.2°F in May, and 66.8°F–72.3°F in June.

Table 7-24a. Distribution of April–May 7DADM Water Temperatures in Relation to USEPA Criteria for Steelhead Smoltification (57.2˚F) at the Confluence of the Stanislaus River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May				June			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	51.2	51.2	51.2	51.1	54.3	54.3	54.3	53.7	57.1	57.2	56.3	54.9
10	54.7	54.9	54.9	54.2	57.6	57.9	57.4	56.2	61.2	61.0	59.9	58.2
20	55.7	55.9	55.8	55.1	58.7	59.1	58.4	57.1	62.6	62.8	61.9	59.9
30	56.6	56.7	56.5	55.9	59.5	59.8	59.0	57.6	63.4	63.6	62.9	61.0
40	57.3	57.4	57.2	56.7	60.0	60.4	59.5	58.1	64.7	65.0	64.3	62.1
50	58.1	58.1	57.9	57.3	60.7	60.9	60.1	59.0	65.8	66.5	65.5	63.4
60	58.9	59.1	58.7	58.1	61.5	61.6	60.9	59.7	68.2	68.6	66.5	64.8
70	59.9	60.0	59.6	58.9	62.7	62.7	61.8	60.6	70.0	70.0	68.3	66.7
80	61.2	61.6	60.7	59.6	64.7	64.0	62.9	61.8	71.5	71.3	70.7	69.5
90	63.1	63.2	61.7	60.7	66.4	66.2	65.0	64.2	73.3	73.2	73.0	72.3
Max	67.1	66.9	66.3	66.2	72.9	71.7	70.8	67.8	77.3	77.4	78.3	78.1
Avg	58.5	58.6	58.2	57.4	61.5	61.5	60.7	59.5	66.8	66.9	66.0	64.4
Change		0.1	-0.3	-1.1		0.0	-0.8	-2.1		0.1	-0.8	-2.4

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-24b. Distribution of April–May 7DADM Water Temperatures in Relation to USEPA Criteria for Steelhead Smoltification (57.2˚F) at the Confluence of the Tuolumne River under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May				June			
Percentile	Baseline	LSJR Alt 2	LSJR Alt3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	52.7	52.7	52.7	52.7	55.7	55.7	55.6	55.6	59.2	59.4	58.3	58.1
10	55.5	55.6	55.3	54.9	59.4	59.2	58.1	57.8	61.8	62.1	60.8	60.6
20	56.9	56.9	56.6	55.9	61.0	60.8	58.9	58.8	63.0	63.1	61.8	61.5
30	58.0	58.0	57.5	56.8	62.3	61.7	59.6	59.3	64.4	64.3	62.6	62.1
40	59.3	59.4	58.3	57.4	63.6	62.5	60.2	59.8	70.9	66.5	63.3	62.8
50	60.7	60.8	59.2	57.7	65.4	63.6	60.7	60.4	74.3	68.7	64.1	63.4
60	62.6	62.3	59.8	58.2	67.3	64.7	61.1	61.1	76.9	70.1	65.2	64.0
70	65.1	63.5	60.7	58.8	69.4	66.3	61.9	61.7	78.1	73.2	67.1	65.0
80	66.9	64.9	61.5	59.4	71.1	67.9	63.1	62.3	79.2	75.5	71.6	68.3
90	69.0	66.5	62.9	60.5	73.2	70.2	65.2	63.2	81.2	78.8	75.5	71.8
Max	74.0	73.5	71.4	67.7	77.6	75.1	69.1	66.0	86.1	85.1	85.1	83.8
Avg	61.7	61.0	59.2	57.9	65.9	64.2	61.1	60.5	72.2	69.4	66.2	64.9
Change		-0.7	-2.5	-3.8		-1.7	-4.8	-5.4		-2.8	-6.0	-7.3

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-24c. Distribution of April–May 7DADM Water Temperatures in Relation to USEPA Criteria for Steelhead Smoltification (57.2˚F) at the Confluence of the Merced River Under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May				June			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	52.1	52.1	52.2	52.2	55.9	55.8	55.8	55.1	57.1	57.3	57.4	57.3
10	58.2	58.3	57.6	55.9	61.2	61.3	60.0	58.5	62.4	62.4	62.4	62.2
20	60.5	60.7	59.5	57.5	63.7	63.0	61.1	59.9	65.4	65.0	64.8	63.6
30	62.0	62.2	60.6	58.9	65.3	64.0	62.1	60.6	69.8	68.0	66.3	64.6
40	63.0	63.2	61.3	59.7	67.0	65.0	62.9	61.4	72.8	70.4	67.7	66.1
50	64.0	63.9	61.9	60.4	68.8	66.0	63.6	62.1	74.2	71.7	69.1	67.4
60	65.0	64.7	62.5	61.1	70.0	67.0	64.5	62.9	75.4	72.7	70.0	68.4
70	66.4	65.4	63.2	61.7	71.3	68.1	65.5	64.0	76.4	74.0	71.5	69.7
80	67.6	66.3	63.8	62.4	72.6	69.5	66.7	65.2	77.5	75.5	73.4	72.2
90	69.6	67.6	64.9	63.5	74.3	70.6	68.5	67.0	78.9	77.4	75.9	74.7
Max	73.2	73.9	73.4	71.7	78.1	75.2	72.2	71.5	83.5	83.3	81.1	80.8
Avg	64.0	63.5	61.7	60.2	68.2	66.1	63.9	62.5	72.3	70.7	69.0	67.8
Change		-0.5	-2.2	-3.8		-2.1	-4.3	-5.7		-1.6	-3.3	-4.6

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

Table 7-24d. Distribution of April–June 7DADM Water Temperatures in Relation to USEPA Criteria for Steelhead Smoltification (57.2˚F) in the San Joaquin River at Vernalis under Modeled Baseline Conditions and LSJR Alternatives 2, 3, and 4

	April				May				June			
Percentile	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4	Baseline	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Min	54.7	54.7	54.7	54.6	59.6	59.8	58.8	57.8	62.2	62.1	61.2	59.9
10	58.0	58.1	57.8	57.6	61.7	61.8	60.8	60.2	65.7	65.8	64.4	63.5
20	59.1	59.3	59.1	58.4	63.1	63.1	61.7	61.0	66.9	66.9	65.6	64.4
30	59.9	60.0	59.8	59.0	64.0	63.9	62.4	61.4	67.8	67.8	66.5	65.1
40	60.7	60.8	60.3	59.6	64.6	64.5	63.0	62.0	68.6	68.7	67.2	65.8
50	61.5	61.6	61.0	60.1	65.3	65.1	63.7	62.7	69.9	69.7	68.0	66.5
60	62.2	62.3	61.6	60.6	66.2	65.8	64.2	63.3	71.3	71.1	68.7	67.1
70	63.1	63.1	62.2	61.0	67.1	66.5	65.1	64.0	72.6	72.3	69.8	68.0
80	63.9	63.8	62.8	61.7	68.4	67.5	66.0	64.8	73.8	73.6	72.0	70.4
90	65.5	65.3	63.7	62.6	69.9	69.0	67.4	66.0	75.7	75.6	74.5	73.4
Max	69.9	68.8	69.3	68.3	75.0	74.2	71.3	68.9	80.2	80.1	80.1	80.4
Avg	61.6	61.6	60.9	60.1	65.7	65.3	63.9	62.9	70.3	70.2	68.7	67.3
Change		0.0	-0.7	-1.5		-0.3	-1.8	-2.8		-0.1	-1.7	-3.0

Notes: Table shows the percent of time that a temperature of equal or lower value occurs. Gray shading indicates temperatures that exceed USEPA criteria.

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, exposure of Chinook salmon and steelhead to suboptimal water temperatures on the Stanislaus and LSJR would not substantially change compared to baseline conditions. No substantial changes would occur in the frequency of suboptimal water temperatures for migration, spawning, and incubation life stages in the three eastside tributaries although spring water temperatures would be improved for rearing and outmigrating salmon in the Tuolumne and Merced Rivers. Other native fishes would experience a similar range of seasonal water temperatures and therefore would not be substantially affected by implementation of this alternative. Impacts on Chinook salmon, steelhead, and other native fishes would not be adverse and would be less than significant.

Adult Migration

Under LSJR Alternative 2, the frequency of suboptimal water temperatures for Chinook salmon and steelhead adult migration (as defined by the USEPA criterion of 64.4°F) at the mouths of the Stanislaus, Tuolumne, and Merced Rivers and in the SJR at Vernalis is expected to remain largely unchanged from baseline conditions (Tables 7-20a, 7-20b, 7-20c, and 7-20d). Therefore, water temperature impacts on migrating adult salmon (including adults returning to Merced River Hatchery) and steelhead would be less than significant.

Spawning and Incubation

Under LSJR Alternative 2, the frequency of suboptimal water temperatures for Chinook salmon and steelhead spawning and incubation life stages (as defined by the USEPA criterion of 55.4°F) in the Stanislaus, Tuolumne, and Merced Rivers is not expected to change substantially relative to baseline conditions (Tables 7-21a, 7-21b, and 7-21c). Therefore, water temperature impacts on Chinook salmon and steelhead spawning and incubation life stages (including adult salmon and incubating eggs and fry in the Merced River Hatchery) would not be adverse and would be less than significant.

Juvenile Rearing

Under LSJR Alternative 2, exposure of juvenile salmon to suboptimal rearing temperatures (as defined by the USEPA criterion of 60.8°F) at the mouth of the Stanislaus River during the spring rearing period is not expected to change substantially relative to baseline conditions (Table 7-22a). In the Tuolumne and Merced Rivers, rearing temperatures under LSJR Alternative 2 are expected to improve based on reductions in average temperatures of 1.7°F to 2.1°F in May (Tables 7-22b and 7-22c). In the SJR at Vernalis, spring water temperatures under LSJR Alternative 2 are predicted to be similar to those under baseline conditions (Table 7-22d). Overall, changes in the exposure of juvenile salmon and steelhead during the spring rearing period are not expected to result in significant impacts on natural or hatchery production compared to baseline conditions.

Under LSJR Alternative 2, exposure of juvenile steelhead in the Stanislaus, Tuolumne, and Merced River to suboptimal rearing temperatures (as defined by the USEPA criterion of 64.4°F) in July and August is not expected to change substantially relative to baseline conditions (Tables 7-23a, 7-23b, and 7-23c). Therefore, water temperature impacts on summer rearing conditions for juvenile steelhead would not be adverse and would be less than significant.

Smoltification

Under LSJR Alternative 2, exposure of salmon and steelhead smolts to suboptimal temperatures (as defined by the USEPA criterion of 57.2°F) in the Stanislaus River and SJR at Vernalis is not expected to change substantially relative to baseline conditions (Table 7-24a and 7-24d). However, smolt outmigration conditions in the Tuolumne and Merced Rivers are expected to improve based on reductions in average temperatures of 1.7°F–2.1°F in May and 1.6°F–2.8°F in June over the 34-year modeling period (Tables 7-24b and 7-24c). This represents a beneficial effect on spring outmigration conditions for juvenile salmon and steelhead in the Tuolumne and Merced Rivers (including juvenile salmon reared at the Merced River Hatchery and released in the Merced River). Therefore, adverse impacts would be less than significant.

Other Fish Species

Higher spring flows and associated decreases in spring water temperatures under LSJR Alternative 2 are not expected to substantially affect the structure and composition of native and nonnative fish communities in the three eastside tributaries. The range of seasonal water temperatures predicted to occur under LSJR Alternative 2, including maximum water temperatures occurring in the summer, would remain within the ranges generally experienced by other fishes under baseline conditions. Therefore, adverse impacts would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers and LSJR would experience improved water temperatures primarily during the spring rearing and outmigration months in response to higher flows in each of the tributaries (Tables 7-20a, 7-20b, 7-20c, and 7-20d through Tables 24a, Table 24b, Table 24c, and Table 7-24d). Water temperatures favoring native fish species over nonnative warmwater species would generally be improved relative to baseline conditions. Impacts on Chinook salmon, steelhead, and other native fishes would not be adverse and would be less than significant.

Adult Migration

Under LSJR Alternative 3, exposure of migrating Chinook salmon and steelhead adults to suboptimal water temperatures (as defined by the USEPA criterion of 64.4°F) in the Stanislaus, Tuolumne, Merced, and LSJR would be similar or slightly reduced relative to baseline conditions (Tables 7-20a, 7-20b, 7-20c, and 7-20d). Changes in water temperatures during the fall migration period ranged from little or no change at most locations to a 10 percent reduction in the frequency of suboptimal water temperatures and a 1.2°F reduction in average temperature in the Stanislaus River in October (Tables 7-20a). Therefore, water temperature impacts on migrating adult salmon (including adults returning to Merced River Hatchery) and steelhead would not be adverse and would be less than significant.

Spawning and Incubation

Under LSJR Alternative 3, the percent of time suboptimal water temperatures occur for Chinook salmon and steelhead spawning and incubation life stages (as defined by the USEPA criterion of 55.4°F) in the Stanislaus, Tuolumne, and Merced Rivers is not expected to change substantially relative to baseline conditions (Tables 7-21a, 7-21b, and 7-21c). Changes in the exposure of Chinook salmon and steelhead spawning and incubation life stages to suboptimal water temperatures (as defined by the USEPA criterion of 55.4°F) were characterized by little or no change at most locations. An exception is the 30 percent reduction in the frequency of suboptimal water temperatures and a 1.6°F reduction in average temperature in the Tuolumne River in March (Table 7-21b). Therefore, water temperature impacts on Chinook salmon and steelhead spawning and incubation conditions (including conditions at Merced River Hatchery) would not be adverse and would be less than significant.

Juvenile Rearing

Under LSJR Alternative 3, exposure of juvenile salmon to suboptimal water temperatures (as defined by the USEPA criterion of 60.8°F) during the spring rearing period is expected to decrease in the Stanislaus, Tuolumne and Merced Rivers and LSJR relative to baseline conditions. The largest changes are expected to occur in the Tuolumne River and Merced Rivers where 7DADM temperatures exceeding the USEPA criterion are predicted to decrease in frequency by 10–20 percent in March, 10–20 percent in April, and 10–30 percent in May, corresponding to reductions in average temperatures of 0.4°F–1.2°F in March, 2.2°F–2.5°F in April, and 4.3°F–4.8°F in May (Tables 7-22b and 7-22c). Therefore, implementation of LSJR Alternative 3 would have a beneficial effect on spring rearing conditions for Chinook salmon in the Stanislaus, Tuolumne, and Merced Rivers (including fish reared at the Merced River Hatchery and released upstream of Vernalis), and the LSJR. Adverse impacts would be less than significant.

Under LSJR Alternative 3, juvenile steelhead would experience lower summer water temperatures in the Stanislaus, Tuolumne, and Merced Rivers relative to baseline conditions (Tables 7-23a, 7-23b, and 7-23c). The largest change is expected to occur in the Tuolumne where 7DADM temperatures exceeding the USEPA criterion (64.4°F) in July are predicted to decrease in frequency by approximately 20 percent, corresponding to a reduction in average temperature of 2.0°F (Table 7-23b). Therefore, some improvement in summer rearing conditions for steelhead is expected in the Stanislaus, Tuolumne, and Merced Rivers. Adverse impacts would be less than significant.

Smoltification

Under LSJR Alternative 3, salmon and steelhead smolts would experience lower water temperatures during their outmigration in the Stanislaus, Tuolumne, and Merced Rivers and LSJR relative to baseline conditions (Tables 7-24a, 7-24b, 7-24c, and 7-24d). The largest changes are expected to occur in the Tuolumne River and Merced Rivers where 7DADM temperatures exceeding the USEPA criterion are predicted to decrease in magnitude by an average of 2.2°F–2.5°F in April, 4.3°F–4.8°F in May, and 3.3°F–6.0°F in June (Tables 7-24b and 7-24c). These changes represent improved conditions for smolt development and migration in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR (including juvenile salmon reared at the Merced River Hatchery and released upstream of Vernalis). Adverse impacts would be less than significant.

Other Fish Species

Under LSJR Alternative 3, higher spring flows and associated reductions in water temperature in the Stanislaus, Tuolumne, and Merced Rivers and LSJR could benefit other native species and adversely affect nonnative species, such as largemouth bass and other warmwater species, which prey on or compete with native fishes. Based on reported changes in the abundance and distribution of native and nonnative resident species in the Tuolumne River and other Central Valley streams, higher spring flows and cooler water temperatures that mimic conditions that occur under the natural flow regime provide more appropriate spawning and rearing conditions for native species (Brown and Ford 2002). Increases in spring flows would also improve migration, spawning, and rearing conditions for splittail, sturgeon, striped bass, and other fishes, as well as improve water quality (e.g., water temperature and salinity) in the Stanislaus, Tuolumne, and Merced Rivers and in the LSJR (see Impact AQUA-4, LSJR Alternative 3). Therefore, LSJR Alternative 3 would have beneficial effects on other native fishes in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Impacts on native fish species would not be adverse and would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers and LSJR would experience improved water temperatures primarily during the spring rearing and outmigration months in response to higher flows in each of the tributaries (Tables 7-20a, 7-20b, 7-20c, and 7-20d through Tables 7-24a, 7-24, 7-24c, and 7-24d). Water temperatures favoring native fish species over nonnative warmwater species would be improved relative to baseline conditions. Impacts on Chinook salmon, steelhead, and other native fishes would not be adverse and would be less than significant.

Adult Migration

LSJR Alternative 4, water temperatures for migrating Chinook salmon and steelhead in the Stanislaus, Tuolumne, Merced, and LSJR would be similar or slightly improved relative to baseline conditions (Tables 7-20a, 7-20b, 7-20c, and 7-20d). Changes in average water temperature during the fall migration period ranged from little or no change at most locations to a 1.0°F reduction in average temperature in the Tuolumne River in September (Table 7-20b). Therefore, water temperature impacts on migrating adult salmon (including adults returning to Merced River Hatchery) and steelhead would not be adverse and would be less than significant.

Spawning and Incubation

Under LSJR Alternative 4, no substantial changes are predicted to occur in the frequency of suboptimal water temperatures for Chinook salmon and steelhead spawning and incubation life stages (as defined by the USEPA criterion of 55.4°F) in the Stanislaus, Tuolumne, and Merced Rivers (Tables 7-21a, 7-21b, and 7-21c). Some improvement in water temperatures would occur in February and March when the frequency of water temperatures exceeding the USEPA criterion are expected to decline by 10–40 percent, and average temperatures are expected to decline by up to 2.2°F. Adverse impacts would be less than significant.

Juvenile Rearing

Implementation of LSJR Alternative 4 would substantially reduce the exposure of juvenile salmon to suboptimal water temperatures during the spring rearing period in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Under this alternative, modeled 7DADM temperatures exceeding the USEPA criterion are predicted to decline in frequency by approximately 0–30 percent in March, 20–40 percent in April, and 10–30 percent in May, and to be reduced in magnitude by an average of 0.8°F–2.2°F in March, 1.1°F–3.8°F in April, and 2.1°F–5.7°F in May (Tables 7-22a, 7-22b, 7-22c, and 7-22d). These changes represent substantial increases in the frequency, duration, and longitudinal extent of suitable rearing temperatures for juvenile salmon in the LSJR and tributaries. Thus, implementation of LSJR Alternative 4 would have beneficial effects on spring rearing conditions for

Chinook salmon in the Stanislaus, Tuolumne, and Merced Rivers (including juvenile salmon reared at the Merced River Hatchery), and LSJR. Adverse impacts would be less than significant.

Under LSJR Alternative 4, substantial changes in the frequency of suboptimal water temperatures for juvenile steelhead (as defined by the USEPA criterion of 64.4°F) during the summer rearing months are only expected to occur in the Tuolumne River where 7DADM temperatures exceeding the USEPA criterion are predicted to decrease in frequency by 20 percent, and to decrease in magnitude by an average of 1.7°F (Table 7-23b). Adverse impacts would be less than significant.

Smoltification

Under LSJR Alternative 4, salmon and steelhead smolts would experience substantial reductions in exposure to suboptimal water temperatures (as defined by the USEPA criterion of 57.2°F) during the spring outmigration period in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR relative to baseline conditions (Tables 7-24a, 7-24b, 7-24c, and 7-24d). Modeled 7DADM temperatures exceeding the USEPA criterion at the mouths of the Stanislaus, Tuolumne, and Merced Rivers and in the SJR at Vernalis are predicted to decrease in frequency by 20 percent or less but decrease in magnitude by an average of 1.1°F–3.8°F in April, 2.1°F–5.7°F in May, and 2.4°F–7.3°F in June. These changes represent substantial improvement in conditions for smolt development and migration in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR (including juvenile salmon reared at the Merced River Hatchery and released). Adverse impacts would be less than significant.

Other Fish Species

Under LSJR Alternative 4, further increases in spring flows and associated reductions in water temperature (compared to those occurring under LSJR Alternative 3) are expected to further increase the quantity and quality of habitat for native fish species in the Stanislaus, Tuolumne, Merced, and LSJR. As discussed under LSJR Alternative 3, the predicted changes in flows and water temperatures would be expected to reduce the distribution and abundance of nonnative fishes and their negative impacts (e.g., predation) on native fishes (see Impact AQUA-10, LSJR Alternative 4). Therefore, LSJR Alternative 4 would have beneficial effects on native fishes in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.

Impact AQUA-5: Changes in exposure to pollutants resulting from changes in flow

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

In general, surface water originating in the three eastside tributary watersheds is good quality and has low salinity concentrations. As increased flow due to precipitation or reservoir operations mobilizes sediment, pollutant levels in the water column have the potential to increase if present in the sediment. Certain land uses, such as abandoned mining operations, in the tributary watersheds have leached different pollutants into the rivers. These pollutants include toxic trace metals (e.g., copper, zinc, and cadmium) (Boles et al. 1988). This has increased known pollutant concentrations in river sediment, which can result in increased fish mortality.

Increased flows under the LSJR alternatives have the potential to increase mobilization and concentration of pollutants in surface waters in the three eastside tributaries and LSJR, potentially increasing exposure of aquatic organisms to toxic substances. While copper, zinc, and cadmium tolerance limits exist for juvenile Chinook salmon (Boles et al. 1988), direct effects on fish cannot be accurately or precisely quantified given the current understanding of the complex processes involved in mobilization and fate of sediment-linked toxins. The volume and concentrations of pollutants that could be mobilized into rivers are generally unknown, and site-specific analyses would be needed to confirm real-time concentrations. However, because pollutants attached to sediment enter the water column, the potential for increased toxins in the system can be linked to a change in suspended sediment and turbidity. An increased concentration of toxins as a result of increased flows could adversely impact indicator species. Alternatively, increased flows can also dilute existing pollutants in the water column and any other pollutants that may be mobilized from the sediment on the riverbed and along the river channel, thereby benefiting indicator species.

Decreased flows could increase concentrations of pollutants, adversely impacting indicator species. Decreased flows could also result in increased temperatures, which generally increase the toxic effects of metals and reduce the survival time of Chinook salmon if lethal levels of metals are present. Warming water temperatures can increase pollutant dose because fish respiration and feeding rates must increase to support the higher metabolic rates that result from warmer water temperatures (Myrick and Cech 2004). Additionally, warming water temperatures can reduce the energy reserves that fish utilize to lessen the effects of pollutants (Brooks et al. 2012). Consequently, lower flows and higher temperatures may exacerbate the effects of pollutants (Heugens et al. 2001).

This assessment is qualitative and based on the dilution effects of proposed changes in flows (see Chapter 5, *Surface Hydrology and Water Quality*, Impact WQ-3) and changes in exposure of fish to thermal stress that could increase their uptake and vulnerability to contaminants under each of the LSJR alternatives (see Impact AQUA-4). Potential water quality impacts under the following analysis assumes that dilution from increased flow would result in long-term reductions in contaminant concentrations and exposure of fish to potentially harmful concentrations in the plan area. However, it should be recognized there is uncertainty regarding the effects of flow in addressing contaminant loads because of concerns related to remobilization of pesticides, trace metals, and other contaminants in the sediment, and the need to implement point- and non-point source reduction actions as part of future restoration efforts (McBain and Trush 2002). For a description of expected changes to sediment and turbidity resulting from increased flows, see Impact AQUA-6.

Impact WQ-3 in Chapter 5 was evaluated based on the changes in the 10th percentile and median values of flow. A concentration ratio of more than 1.5 would represent an increase of 50 percent of the baseline concentration and would be expected to cause a significant increase in pollutants when baseline concentrations are approaching water quality objectives for water resources. As detailed in Chapter 5, a concentration ratio of 1.5 would occur if there was a one-third reduction in flow. Therefore, a reduction in 10th percentile or median flows of more than 33 percent for a particular month is considered to be potentially significant and subject to further evaluation.

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, Chinook salmon, steelhead, and other fish species would not experience an increased exposure or vulnerability to contaminants in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Flows were similar in most months and substantially higher in the spring (May and June primarily) compared to baseline conditions (Tables 5-17a, 5-17b, 5-17c, and 5-17d). Reductions in magnitude of the 10th to 90th percentile flows of 10 percent or more occurred in some months but these reductions were associated with the highest flow years (e.g., >50th percentile flows) or flows during the winter and early spring (December–March) when water temperatures are not a concern (see Impact AQUA-4, LSJR Alternative 2). Impacts on Chinook salmon, steelhead, and other fishes would not be adverse and would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, Chinook salmon, steelhead, and other fish species would not experience an increased exposure or vulnerability to contaminants because of higher spring flows and substantial improvement in water temperatures for juvenile rearing and smolt outmigration in the Tuolumne River, the Merced River, and the LSJR (Tables 5-17a, 5-17b, 5-17c, and 5-17d). Reductions in magnitude of the 10th to 90th percentile flows of 10 percent or more occurred in some months but these reductions were associated with the highest flow years (e.g., upper 50th percentile flows) or flows during the winter and early spring (December–March) when water temperatures are not a concern (see Impact AQUA-4, LSJR Alternative 3). Impacts on Chinook salmon, steelhead, and other fishes would not be adverse and would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, Chinook salmon, steelhead, and other fish species would not experience an increased exposure or vulnerability to contaminants because of higher spring flows and substantial improvement in water temperatures for juvenile rearing and smolt outmigration in the Tuolumne River, the Merced River, and the LSJR (Tables 5-17a, 5-17b, 5-17c, and 5-17d). Reductions in magnitude of the 10th to 90th percentile flows of 10 percent or more occurred in some months but these reductions were associated with the highest flow years (e.g., upper 50th percentile flows) or flows during the winter and early spring (December–March) when water temperatures are not a concern (see Impact AQUA-4, LSJR Alternative 4). Impacts on Chinook salmon, steelhead, and other fishes would not be adverse and would be less than significant.

Impact AQUA-6: Changes in exposure to suspended sediment and turbidity resulting from changes in flow

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Higher flows generally have a higher capacity to mobilize and transport sediment in rivers, resulting in higher concentrations of suspended sediment and reduced water clarity (i.e., increased turbidity). Suspended sediments, such as clay, silt, organic matter, plankton, and other microscopic organisms cause turbidity in water that can affect primary productivity, water temperature, DO, and fish feeding. During high-flow events, high concentrations of suspended sediment can settle out and bury stream substrates that provide habitat for aquatic invertebrates and other important food sources for fish. Sediment that settles out of suspension may also reduce the quality of spawning substrates and entomb or suffocate salmonid eggs and alevins in stream gravels. Other effects of suspended sediment on fish include displacement from key habitats, physiological stress, respiratory impairment, damage to gills, reduced tolerance to disease and toxicants, and direct mortality at very high levels (Newcombe and Jensen 1996; Bash et al. 2001).

High turbidity levels generally reduce the efficiency of piscivorous (fish-eating) and planktivorous (plankton-eating) fish in finding and capturing their prey (Henley et al. 2000). Higher turbidity may favor the survival of young fish by protecting them from predators (De Robertis et al. 2003), but can also reduce the feeding rates of young fish that depend on sight to detect prey (Newcombe and Jensen 1996). Typically, when waters are turbid, predator success rate is less. Juvenile salmon losses to predators may be reduced by at least 45 percent in turbid stream reaches relative to clearer water reaches (Gregory and Levings 1998). Turbid water may also stimulate faster migration rates, which reduces the time young fish are exposed to freshwater mortality risks (USBR 2008). In the southern Delta, low turbidity contributes to poor feeding conditions and potentially higher predation rates on delta smelt and other pelagic species. For delta smelt, it appears that turbidity enhances visual contrast and detection of prey (Baskerville-Bridges et al. 2004). Feeding of other planktivorous species, such as longfin smelt, may also be similarly affected by turbidity (Nobriga et al. 2008; USBR 2011).

Potential effects of the LSJR alternatives on the frequency and magnitude of flow events capable of inducing sediment transport in the upper and lower reaches of the Stanislaus, Tuolumne, and Merced Rivers were evaluated to determine the potential for changes in exposure of fish to increases in suspended sediment concentrations and turbidity (Impact AQUA-6), and changes in channel complexity (habitat diversity) and spawning gravel quality resulting from gravel mobilization (Impact AQUA-8). Under baseline conditions, gravel transport is estimated to occur at flows between 5,000 and 8,000 cfs in the Stanislaus River (Kondolf et al. 2001), flows between 7,000 and 9,800 cfs in the upper reaches of the Tuolumne River (McBain and Trush 2000), and flows greater than 4,800 cfs in the upper reaches of the Merced River (Stillwater Sciences 2001; Kondolf et al. 1996). Flows below these levels (above approximately 2,000–3,000 cfs) can mobilize finer sediment in the mid- to lower sand-bedded portions of these tributaries, potentially increasing suspended sediment and turbidity in the lower reaches of these tributaries and the LSJR. These flows were used as thresholds to evaluate potential impacts on the indicator fish species and aquatic habitat resulting from changes in the frequency and magnitude of bed-mobilizing flows in the Stanislaus, Tuolumne, and Merced Rivers. This analysis is based on modeled peak monthly flows in the wettest years of the 1922–2003 modeling period (Chapter 6, *Flooding, Sediment, and Erosion*, Tables 6-10 through 6-12).

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, the modeling of peak flows during the wettest years of the 1922–2003 modeling period indicates that the frequency and magnitude of flows exceeding the thresholds associated with gravel mobilization in the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers would be similar to that occurring under baseline conditions (Tables 6-9 through 6-12; Chapter 6, *Flooding, Sediment, and Erosion*, Impact FLO-1) In addition, no substantial changes would occur in the frequency of peak flows capable of inducing increased turbidity and suspended sediment in the lower portions of Stanislaus, Tuolumne, and Merced Rivers (>2,000 cfs). Therefore, no long-term changes in suspended sediment and turbidity affecting aquatic resources would occur. Adverse impacts would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, peak flows associated with gravel mobilization in the Stanislaus, Tuolumne, and Merced Rivers would remain unchanged or decrease in frequency relative to baseline conditions (Tables 6-10 through 6-12; Chapter 6, *Flooding, Sediment, and Erosion*, Impact FLO-1). Peak flow events capable of transporting fine sediment in the lower sand-bedded reaches of these tributaries are predicted to increase in frequency in the Stanislaus River during the 82-year modeling period (15 years under LSJR Alternative 3 compared to 11 years under baseline conditions; see Table 6-10) but the magnitude of these events is expected to remain within the range of historical levels experienced by native fishes and other aquatic species. Furthermore, sediment carried into the southern Delta is generally considered beneficial to delta smelt and other pelagic fish species because of reductions in turbidity that have contributed to habitat degradation for pelagic fishes in the Bay-Delta estuary (Ferrari et al. 2013). Therefore, no long-term changes in suspended sediment and turbidity affecting aquatic resources would occur. Adverse impacts would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, peak flows associated with gravel mobilization would increase in frequency in the Stanislaus River and decrease in frequency in the Tuolumne and Merced River (Tables 6-10 through 6-12; Chapter 6, *Flooding, Sediment, and Erosion*, Impact FLO-1). However, increases in the frequency of gravel-mobilization events are not expected to substantially affect native fish communities or aquatic habitat because of the low frequency of these events over the 82-year modeling period. Furthermore, such events are generally recognized as beneficial for aquatic habitat maintenance (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001, 2004). Similar to LSJR Alternative 3, peak flow events capable of transporting fine sediment in the lower sand-bedded reaches of these tributaries could increase in frequency in the Stanislaus River (16 years under LSJR Alternative 4 compared to 11 years under baseline conditions; see Table 6-10) but the magnitude of these events is expected to remain within the range of historical levels experienced by native fishes and other aquatic species. Furthermore, sediment carried into the southern Delta is generally considered beneficial to delta smelt and other pelagic fish species because of reductions in turbidity that have contributed to habitat degradation for pelagic fishes in the Bay-Delta estuary. Therefore, no long-term changes in suspended sediment and turbidity affecting aquatic resources would occur. Adverse impacts would be less than significant.

Impact AQUA-7: Changes in redd dewatering resulting from flow fluctuations

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Reservoir operations can result in fluctuations in river flows that can dewater Chinook salmon and steelhead redds. In general, redd dewatering depends on site conditions selected by females for spawning, the magnitude and duration of subsequent flow reductions during the incubation period, and the developmental stage of the embryos or fry at the time of the flow reductions. Spawning site selection depends on the presence of suitable water depths, velocities, and substrate sizes for adult spawning activities and redd construction. Suitable spawning sites are also characterized by bed topography that facilitates flow exchange through the gravel, as occurs in the transitional areas between pools and riffles (Shapovalov and Taft 1954) or where other channel features induce upwelling or downwelling (Geist et al. 2001). Following egg deposition and completion of redd construction, the survival of eggs and alevins (yolk-sac fry) depends on the maintenance of suitable hyporheic flow[16], water temperatures, and DO levels. Salmonid eggs can tolerate temporary (1–5 weeks) dewatering provided that the temperature remains suitable and the eggs remain moist (Becker et al. 1982; Reiser and White 1983; McMichael et al. 2005). Alevins are less tolerant of dewatering because of their dependence on hyporheic flow and relatively high concentrations of DO in the surrounding water (Becker et al. 1982).

Potential redd dewatering impacts were evaluated based on habitat suitability criteria (HSC) for Chinook salmon and steelhead spawning (water depths) and published data on egg burial depths. Depth HSCs and redd measurements for Chinook salmon and steelhead in the three eastside tributaries and other Central Valley rivers indicate that the shallowest depth utilized by spawning Chinook salmon and steelhead adults is approximately 0.5 ft (USFWS1993, 1997, 2010; MID 2013; Stillwater Sciences 2013). Redds become fully dewatered when the surface of the hyporheic zone drops below the elevation of the egg pocket. However, impacts may occur with reductions in surface flow depending on site conditions (e.g., intragravel permeability) and developmental stage of the embryos or fry (Reiser and White 1983). Published measurements of egg burial depths (excavation depth to top of main egg pocket) average 0.5–1.4 ft for Chinook salmon and 0.4–0.8 inches for steelhead (DeVries 1997). Because of variability in potential effects related to site conditions and developmental stage, the following analysis includes the assumption that embryos and fry in the shallowest redds begin to experience adverse intragravel conditions with flow reductions exceeding the minimum spawning depth (0.5 ft). Additionally, based on the range of egg burial depths cited above, complete dewatering of the shallowest redds is assumed to occur with flow reductions of approximately 1 foot. Therefore, significant adverse impacts could occur if the frequency of flow reduction of 1 foot or more increases by 10 percent or more under the alternatives.

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[16] The *hyporheic zone* is the zone below and adjacent to the streambed where surface and subsurface water mix and are readily exchanged.

Table 7-25 summarizes the flow-depth relationships that were used to calculate average monthly changes in water depth over redds during the Chinook salmon and steelhead incubation periods. These relationships describe the average change in water depth as a function of flow based on a series of channel cross sections and flow-stage relationships within the principal spawning reaches of the Stanislaus, Tuolumne, and Merced Rivers.[17] Polynomial equations were fit to the average flow-depth relationships for each tributary and used to calculate the average monthly change in water depth during the Chinook salmon and steelhead incubation period based on monthly modeled reservoir releases at Goodwin Dam, La Grange Dam, and Crocker-Huffman Dam for the years 1922–2003. It should be recognized that monthly flow modeling provides only a coarse approximation of potential impacts associated with redd dewatering because such impacts are highly sensitive to daily variation in flows, spawning timings, and daily reservoir operational decisions and rules that govern the magnitude and rate of flow reductions during the Chinook salmon spawning and incubation season. Under current operations, redd dewatering has not been identified as a significant stressor on Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers.

Table 7-25. Flow-Depth Relationships for the Principal Chinook Salmon and Steelhead Spawning Reaches in the Stanislaus, Tuolumne, and Merced Rivers

Stanislaus at Goodwin		Tuolumne at La Grange		Merced at Crocker Huffman	
flow (cfs)	depth (feet)	flow (cfs)	depth (feet)	flow (cfs)	depth (feet)
250	3.03	250	3.40	250	2.46
500	3.64	500	3.88	500	2.98
1,000	4.60	1,000	4.61	1,000	3.30
1,500	5.59	1,500	5.13	1,500	3.69
2,000	6.24	2,000	5.52	2,000	4.03
2,500	6.81	2,500	5.85	2,500	4.35
3,000	7.29	3,000	6.04	3,000	4.64
4,000	8.22	4,000	6.28	4,000	5.09
5,000	9.01	5,000	5.95	5,000	5.62

cfs = cubic feet per second

Tables 7-26a, 7-26b, and 7-26c summarize the frequency and magnitude of monthly changes in water depth during the primary Chinook salmon and steelhead incubation months (October–May) under baseline conditions and LSJR Alternatives 2, 3, and 4. The results are shown for 10th, 50th, 90th percentiles and averages for the years 1922–2003. A positive value for a given month indicates an increase in water depth from the previous month, while a negative value indicates a decrease in water depth from the previous month.

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[17] These relationships were developed from 36 cross sections on the Stanislaus River between RM 33.3 and 58.5, 37 cross sections on the Tuolumne River between RM 29.2 and 53.1, and 45 cross sections on the Merced River between RM 27.4 and 52.2 (see AD Consultants et al. 2009).

Table 7-26a. Average Monthly Changes in Water Depth (Feet) in the Principal Chinook Salmon and Steelhead Spawning Reach of the Stanislaus River

Percentile	Oct–Nov	Nov–Dec	Dec–Jan	Jan–Feb	Feb–Mar	Mar–Apr	Apr–May
Baseline							
10	-4.2	0.0	0.0	-0.1	-3.2	-0.2	-0.4
50	-4.0	0.0	0.0	0.0	0.0	0.7	0.0
90	-3.8	0.0	0.7	3.8	5.4	5.5	0.5
LSJR Alt 2							
10	-4.2	0.0	0.0	0.0	-3.1	-0.2	-0.4
50	-4.1	0.0	0.0	0.0	0.0	0.9	0.0
90	-3.8	0.0	1.3	3.7	3.7	5.4	0.5
LSJR Alt 3							
10	-4.8	0.0	0.0	0.0	-1.2	-0.1	-0.4
50	-4.3	0.0	0.0	3.3	0.3	0.9	0.3
90	-3.9	0.1	0.1	4.8	3.6	3.7	1.5
LSJR Alt 4							
10	-4.8	0.0	0.0	0.0	-0.9	-0.1	-0.5
50	-4.3	0.0	0.0	3.6	0.5	1.0	0.8
90	-3.9	0.0	0.1	5.7	3.3	2.2	2.0

Table 7-26b. Average Monthly Changes in Water Depth (Feet) in the Principal Chinook Salmon and Steelhead Spawning Reach of the Tuolumne River

Percentile	Oct–Nov	Nov–Dec	Dec–Jan	Jan–Feb	Feb–Mar	Mar–Apr	Apr–May
Baseline							
10	-0.2	0.0	0.0	0.0	-0.2	-1.1	-1.7
50	0.0	0.0	0.0	0.0	0.0	0.2	0.0
90	0.0	0.8	1.5	2.1	1.6	4.5	0.3
LSJR Alt 2							
10	-0.2	0.0	0.0	0.0	-0.6	-1.1	-1.2
50	0.0	0.0	0.0	0.0	0.0	0.2	0.0
90	0.0	0.5	1.6	3.8	3.4	4.2	0.7
LSJR Alt 3							
10	-0.2	-0.7	0.0	0.0	-0.6	-0.7	-0.5
50	0.0	0.0	0.0	0.9	0.2	0.6	0.4
90	0.2	0.0	1.2	4.9	1.9	2.1	1.5
LSJR Alt 4							
10	-0.2	-0.7	0.0	0.0	-0.7	-0.5	-0.5
50	0.0	0.0	0.0	1.8	0.4	0.8	0.4
90	0.1	0.0	0.0	5.4	1.9	1.9	1.4

Table 7-26c. Average Monthly Changes in Water Depth (Feet) in the Principal Chinook Salmon and Steelhead Spawning Reach of the Merced River

Percentile	Oct–Nov	Nov–Dec	Dec–Jan	Jan–Feb	Feb–Mar	Mar–Apr	Apr–May
Baseline							
10	-2.7	0.0	0.0	0.0	-0.9	-2.7	-2.5
50	-2.7	0.0	0.0	0.0	0.4	0.0	0.0
90	-2.6	1.0	1.5	3.3	2.7	0.3	2.9
LSJR Alt 2							
10	-2.7	0.0	0.0	-0.1	-0.9	-2.7	0.0
50	-2.7	0.0	0.0	0.0	0.6	0.0	0.3
90	-0.6	1.0	1.2	2.9	2.7	0.4	2.9
LSJR Alt 3							
10	-2.7	-3.0	0.0	0.0	-0.7	-0.6	0.0
50	-2.7	0.0	0.0	0.0	0.4	0.3	0.5
90	0.0	0.0	0.8	3.4	2.8	0.6	1.2
LSJR Alt 4							
10	-2.7	-3.0	0.0	0.0	-0.8	-0.1	0.0
50	-2.7	0.0	0.0	2.7	0.2	0.4	0.6
90	0.0	0.0	0.5	3.8	2.9	0.8	1.3

Baseline

Seasonal flow fluctuations in the Stanislaus, Tuolumne, and Merced Rivers during the Chinook salmon and steelhead spawning and incubation seasons are generally characterized by flow reductions in the fall (following pulse flows typically in late October to attract Chinook salmon into the tributaries), relatively stable base flows through the winter (punctuated by storm-driven flow pulses), sustained higher flows in the late winter and spring, and a flow reduction to summer base flows in late spring or summer. Under modeled baseline conditions, reductions in monthly flows below Goodwin, La Grange, and Crocker-Huffman Dams typically occur between October and November, resulting in average changes in water depth of 3.7 ft in the Stanislaus River, 0.1 ft in the Tuolumne River, and 2.4 ft in the Merced River (Tables 7-26a, 7-26b, and 7-26c). Although the potential exists for redd dewatering in the Stanislaus and Merced Rivers, the incidence of redd dewatering is likely low because most adults do not spawn until after the fall attraction flow. Beginning in November, modeled baseline flows generally remain stable or increase during the Chinook salmon and steelhead spawning and incubation season.

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, no substantial changes would occur in the frequency and magnitude of flow reductions associated with potential Chinook salmon and steelhead redd dewatering impacts (decreases in water depth of greater than 0.5 ft) relative to baseline conditions (Tables 7-26a, 7-26b, and 7-26c). Therefore, redd dewatering impacts on Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, no substantial changes would occur in the frequency and magnitude of flow reductions associated with potential Chinook salmon and steelhead redd dewatering impacts (decreases in water depth of greater than 0.5 ft) relative to baseline conditions (Tables 7-26a, 7-26b, and 7-26c). Therefore, redd dewatering impacts on Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, no substantial changes would occur in the frequency and magnitude of flow reductions associated with potential Chinook salmon and steelhead redd dewatering impacts (decreases in water depth of greater than 0.5 ft) relative to baseline conditions (Tables 7-26a, 7-26b, and 7-26c). Therefore, redd dewatering impacts on Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers would be less than significant.

Impact AQUA-8: Changes in spawning and rearing habitat quality resulting from changes in peak flows

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

In general, historical dam operations and mining operations in the Stanislaus, Tuolumne, and Merced Rivers have eliminated natural gravel sources and channel forming flows that maintain the geomorphic processes needed to maintain high-quality spawning and rearing habitat for native salmonids and other fishes (McBain and Trush 2002). As discussed for Impact AQUA-6, gravel transport is estimated to occur at flows between 5,000 and 8,000 cfs in the Stanislaus River (Kondolf et al. 2001), between 7,050 and 9,800 cfs in the upper reaches of the Tuolumne River (McBain and Trush 2000), and at flows greater than 4,800 cfs in the upper reaches of the Merced River (Stillwater Sciences 2001; Kondolf et al. 1996). These flows served as thresholds for evaluating the potential for changes in the frequency and magnitude of bed-mobilizing flows that could affect the quality of spawning and rearing habitat in the Stanislaus, Tuolumne, and Merced Rivers. This analysis is based on modeled peak monthly flows in the wettest years of the 1922–2003 modeling period (Chapter 6, *Flooding, Sediment, and Erosion*, Tables 6-10 through 6-12).

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, modeling of peak flows during the wettest years of the 1922–2003 modeling period indicates that the frequency and magnitude of flows exceeding the thresholds associated with gravel mobilization would not change substantially in the Stanislaus, Tuolumne, and Merced Rivers relative to baseline conditions (Tables 6-10 through 6-12; Chapter 6, *Flooding, Sediment, and Erosion*, Impact FLO-1). Under baseline conditions and LSJR Alternative 2, peak monthly flows would exceed the minimum threshold flows (5,000 cfs in the Stanislaus River, 7,000 cfs in the Tuolumne River, and 4,800 cfs in the Merced River) in 3 years in the Stanislaus River, 9 years in the Tuolumne River, and 7 years in the Merced River (Tables 6-10, 6-11, and 6-12). Therefore, no long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality would occur. Adverse impacts would be less than significant.

LSJR Alternative 3 (Less than significant)

Similar to LSJR Alternative 2, changes in peak flows under LSJR Alternative 3 are not expected to affect the frequency and magnitude of gravel mobilization events in the Stanislaus, Tuolumne, and Merced Rivers (Tables 6-9 through 6-12; Chapter 6, *Flooding, Sediment, and Erosion*, Impact FLO-1). Therefore, no long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality would occur. Adverse impacts would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, peak flows associated with gravel mobilization would increase in frequency in the Stanislaus River and decrease in frequency in the Tuolumne and Merced River (Tables 6-10 through 6-12; Chapter 6, *Flooding, Sediment, and Erosion*, Impact FLO-1). However, no substantial long-term effects on geomorphic conditions affecting spawning and rearing habitat quality are expected to occur because of the low frequency of these events over the 82-year modeling period. Furthermore, such events are generally recognized as beneficial for aquatic habitat maintenance (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2001, 2004). Therefore, no long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality would occur. Adverse impacts would be less than significant.

Impact AQUA-9: Changes in food availability resulting from changes in flow and floodplain inundation

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Losses and degradation of riparian and floodplain habitat and reductions in natural hydrologic variability that connect these habitats to the aquatic ecosystem have been identified as a major stressor on native fish populations through direct impacts on spawning and rearing habitat availability (Impact AQUA-3) and indirect impacts on aquatic productivity and food web support provided by seasonal floodplain inundation (see Appendix C, *Technical Report on the Scientific Basis for Alternatives San Joaquin River Flow and Southern Delta Salinity Objectives*).

The impacts of the alternatives on food web support for Chinook salmon, steelhead, and other native fishes are qualitatively evaluated based on the frequency and magnitude of floodplain inundation in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR (see Impact AQUA-3). As discussed in Appendix C, establishing a more natural flow regime is anticipated to enhance the processes supporting food production for native fish species and other organisms. Therefore, higher spring flows that mimic the natural seasonal flow pattern are assumed to provide increased food web support by enhancing primary and secondary production on floodplains and potentially increasing inputs or organic carbon and nutrients from floodplains to downstream waters.

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, no substantial long-term negative changes on food web support are expected based on predicted changes in the frequency and magnitude of floodplain inundation over the 82-year modeling period (see Impact AQUA-3, LSJR Alternative 2; Tables 7-16a, 7-16b, 7-17c, and 7-17d). Therefore, adverse impacts would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, higher spring flows and associated increases in riparian and floodplain inundation in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR (see Impact AQUA-3, LSJR Alternative 3) would potentially increase the abundance of aquatic and terrestrial invertebrates available to juvenile salmon and other native fishes that use floodplain habitats for spawning and/or early rearing (e.g., Sacramento splittail), and increase inputs of organic matter and nutrients to the riverine and estuarine ecosystem. Potential increases in food abundance and growth opportunities for fish on floodplains as well as downstream food web support would contribute to the benefits associated with increases in physical habitat discussed in Impact AQUA-3. This represents a beneficial effect on aquatic resources in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Adverse impacts would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, further increases in the frequency, magnitude, and duration of floodplain inundation relative to LSJR Alternative 3 would further enhance aquatic productivity and food web support for native fish species and other aquatic resources. This represents a beneficial effect on aquatic resources in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Adverse impacts would be less than significant.

Impact AQUA-10: Changes in predation risk resulting from changes in flow and water temperature

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Predation pressures on indicator species are considerable under baseline conditions (SJRGA 2009, 2010). Predation impact mechanisms include changes in ecosystem structure that increase prey vulnerability or increase predator feeding efficiency. Several impact mechanisms may contribute to increased predation, including altered flow regimes, removal of riparian cover, changes in turbidity, and reduced habitat heterogeneity (Moyle 2002; Ferrari et al. 2013). These mechanisms generally alter predator-prey relationships by disrupting or reducing cover, space, and refuge. Increased prey vulnerability is also associated with other environmental conditions, including increased water temperature, water diversions, pollutants, and fishing (Spence et al. 1996; Moyle 2002).

Predation by numerous native and nonnative species is exacerbated by water management, channel modifications, and artificial structures (e.g., dams) within the plan area. Fish, avian, and wildlife species that prey on steelhead and fall-run Chinook salmon in the plan area include striped bass, Sacramento pikeminnow, smallmouth bass, trout, largemouth bass, gulls, mergansers, cormorants, river otters, herons, sea lions, and seals (USDOI 2008). Infrastructure or operational elements of the water conveyance system may lead to behavioral changes, metabolic disruption, or other biological and ecological outcomes that increase prey vulnerability to predators (BPA 2010). Increased water temperatures or other environmental conditions may place increased metabolic demands on susceptible groups of fish and hinder their flight response or capability to take refuge from threats by predation (Spence et al. 1996). Specifically, warm water temperatures may impact the performance of young salmon or enhance habitat conditions favorable to predatory fishes, thereby increasing losses of young Chinook salmon to predators (Boles et al. 1988). Reductions in shaded riverine aquatic cover can expose fish to increased risk of capture by avian or terrestrial predators (Li et al. 1994; BPA 2010).

As discussed in Appendix C, *Technical Report on the Scientific Basis for Alternatives San Joaquin River Flow and Southern Delta Salinity Objectives*, predation has been identified a significant factor limiting Chinook salmon outmigrant survival in the SJR Basin and southern Delta and a major impediment to Central Valley salmon recovery efforts (EA 1992; TID and MID 1992; FishBio 2013; NMFS 2009c; Dauble et al. 2010). The specific mechanisms by which flow, water temperature, and other flow-related variables affect the success of predator populations and their impact on Chinook salmon and other native fishes are not clearly understood. The relative importance of predation in limiting survival of outmigrating salmon also appears to be strongly influenced by reach-specific factors, such as deepening and simplification of natural channels, as well as dams, diversions, and other artificial structures that concentrate predators, enhance prey vulnerability, or direct outmigrants away from preferred migration routes (Brown et al. 1996; Tucker et al. 1998; Kimmer and Brown 2006; SJRGA 2011). Nevertheless, consistent with broadly recommended restoration strategies in the literature (see Appendix C), a number of studies in Central Valley streams have shown that higher, more variable flows that mimic the natural flow regime to which native fish communities are adapted can effectively limit the success of nonnative fish species, including a number of warmwater species that are predators of juvenile salmonids (EA 1992; McBain & Trush 2000; Brown and Ford 2002; Kiernan et al. 2012).

Predation-related impacts are qualitatively evaluated based on the potential for the LSJR alternatives to modify environmental conditions in the three eastside tributaries that influence predator success or the vulnerability of prey species such as Chinook salmon as steelhead.
This assessment is based on potential changes in predator-prey interactions that could result

from altered flow and temperature conditions. Thus, results from Impact AQUA-3 and Impact AQUA-4 are incorporated in the evaluation, where appropriate.

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, changes in habitat availability and water temperatures (described in the Impact AQUA-3 and Impact AQUA-4 discussions) during the Chinook salmon and steelhead rearing and outmigration periods in the Stanislaus, Tuolumne, and Merced Rivers would not result in significant impacts on these species. Therefore, no negative substantial changes are likely to occur in predator populations or the habitat conditions affecting vulnerability of Chinook salmon and steelhead juveniles to predation in the three eastside tributaries. Adverse impacts would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, increases in spring flows and decreases in water temperature in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR are expected to improve rearing and outmigration conditions for juvenile salmon and steelhead. These conditions are expected to potentially enhance the growth and development of the juveniles and reduce the severity of temperature-related stresses that could increase their vulnerability to predators. Higher flows and cooler water temperatures are also expected to benefit juvenile salmon and steelhead by limiting the distribution and abundance of largemouth bass and other nonnative species, which typically favor lower flows and warmer temperatures, and currently contribute to high mortality rates of juvenile salmon in the lower reaches of these tributaries (see Impact AQUA-3, LSJR Alternative 3). Flows and temperatures in the three eastside tributaries are not expected to decrease substantially in the summer and, therefore, would not affect summer habitat conditions that support predator populations under baseline conditions. Adverse impacts would be less than significant.

LSJR Alternative 4 (Less than significant)

LSJR Alternative 4 is expected to further improve spring habitat conditions supporting juvenile Chinook salmon and steelhead rearing and outmigration (relative to LSJR Alternative 3), and reduce predation impacts by warmwater fishes as described above. Flows and temperatures in the three eastside tributaries are not expected to decrease substantially in the summer and, therefore, would not change summer habitat conditions that support predator populations under baseline conditions. Adverse impacts would be less than significant.

Impact AQUA-11: Changes in disease risk resulting from changes in water temperature

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Disease impacts fish populations by directly increasing mortality or indirectly increasing mortality by adversely affecting the ability of fish to evade predators or perform other essential behaviors such as feeding, swimming, and defending territories (McCullough 1999). Chinook salmon are susceptible to a variety of diseases, many of which have specific temperature requirements. Certain freshwater diseases are known to be more prevalent in cold water. The mycobacterium *Cytophaga psychrophila* produces disease in salmonids at temperatures of 41°F–50°F, and infectious hematopoietic necrosis (IHN) is a viral disease that is most common at 46.4°F–50°F. BKD has been shown to have optimum temperatures for infection below 59°F (McCullough 1999).

While certain diseases are more prevalent in cold water, most of the more significant diseases afflicting LSJR Chinook salmon increase in virulence as temperature increases. For example, water temperatures greater than 56°F favor the bacterial diseases columnaris and furunculosis, while temperatures greater than 65°F favor the protozoan *Ichthyophthirosis* (Boles et al. 1988). Vibrio is caused by the marine bacterium *Vibrio anguillarum* and produces a hemorrhagic septicemia that has optimum growth conditions in waters above 59°F (McCullough 1999). Most warmwater diseases begin to become serious threats above 59°F, and temperatures in the range of 55°F–59°F appear to be least problematic for salmonids in resisting both cold- and warmwater diseases (McCullough 1999). Steelhead are assumed to be susceptible to the same diseases as Chinook salmon. Although very little information exists to quantify changes in infection levels and mortality rates attributable to these diseases, steelhead are probably more susceptible to diseases in freshwater habitats than Chinook salmon. Because steelhead rear in riverine and estuarine habitats for 1–3 years, compared to the 3- to 7-month rearing period of fall-run Chinook salmon, the exposure to disease or disease carrying organisms in these habitats is increased. This is especially true during summer months when flows are lower and temperatures are higher for steelhead. For this impact assessment, the effects of disease on Chinook salmon are assumed to have similar effects on steelhead and to be generally representative of effects on aquatic resources.

Impacts of disease on Chinook salmon and steelhead are assessed by evaluating potential changes in exposure of juvenile salmonids to water temperatures and that could increase physiological stress and susceptibility to disease. To address temperature-related effects, this assessment focuses on daily water temperatures during the warmest months of the year (March–October) at the mouth of each eastside tributary and in the SJR at Vernalis to determine changes in the percent of time that water temperatures could exceed 59°F under baseline conditions and LSJR Alternatives 2, 3, and 4 (Tables 7-27a, 7-27b, 7-27c, and 7-27d). A 10 percent change in the frequency of modeled average daily water temperatures exceeding this threshold was used to determine the potential for increased disease risk.

Table 7-27a. Percent of Time that the 59°F Threshold in the Stanislaus River at the Confluence is Exceeded

Stanislaus – Confluence	March	April	May	June	July	August	September	October
Baseline	16	28	60	95	97	99	93	55
LSJR Alternative 2	17	30	64	94	97	98	92	51
LSJR Alternative 3	10	26	51	91	97	99	96	44
LSJR Alternative 4	4	15	36	79	99	100	97	47

Table 7-27b. Percent Time that the 59°F Threshold in the Tuolumne River at the Confluence is Exceeded

Tuolumne – Confluence	March	April	May	June	July	August	September	October
Baseline	37	55	84	95	100	100	99	92
LSJR Alternative 2	32	55	81	96	100	100	99	93
LSJR Alternative 3	23	35	56	93	100	100	99	91
LSJR Alternative 4	11	15	44	88	100	100	99	91

Table 7-27c. Percent Time the 59°F Threshold in the Merced River at the Confluence is Exceeded

Merced – Confluence	March	April	May	June	July	August	September	October
Baseline	40	84	91	95	100	100	100	95
LSJR Alternative 2	41	84	91	96	100	100	100	95
LSJR Alternative 3	36	74	85	96	100	100	100	94
LSJR Alternative 4	24	56	72	96	100	100	100	94

Table 7-27d. Percent Time that the 59°F Threshold in the SJR at Vernalis is Exceeded

SJR – Vernalis	March	April	May	June	July	August	September	October
Baseline	31	73	98	100	100	100	100	89
LSJR Alternative 2	32	74	98	100	100	100	100	88
LSJR Alternative 3	27	70	95	100	100	100	100	87
LSJR Alternative 4	17	55	88	100	100	100	100	88

LSJR Alternative 2 (Less than significant)

Under LSJR Alternative 2, no substantial changes are predicted to occur in the frequency of average daily water temperatures exceeding the 59°F threshold at the confluences of the Stanislaus, Tuolumne, and Merced Rivers and in the LSJR relative to baseline conditions (Tables 7-27a, 7-27b, 7-27c, and 7-27d). Therefore, the risk of disease associated with exposure of juveniles to water temperatures exceeding 59°F would be similar to that under baseline conditions. Adverse impacts would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, the frequency of spring water temperatures exceeding the 59°F threshold would decrease in all three tributaries and in the LSJR, ranging from less than 5 percent decrease in the SJR at Vernalis to nearly a 30 percent decrease in the Tuolumne River (Table 7-27a, 7-27b, 7-27c, and 7-27d). No substantial changes are predicted to occur in the frequency of water temperatures exceeding 59°F during the summer and fall (July–October) although some improvement (-11 percent) is expected in the Stanislaus River in October. Therefore, the risk of disease associated with exposure of juveniles to water temperatures exceeding 59°F during the spring rearing and outmigration would be reduced compared to baseline conditions. Adverse impacts would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, the frequency of water temperatures exceeding the 59°F threshold would decrease by approximately 10–40 percent in March, April, and May at the mouths of the three tributaries and in the SJR at Vernalis relative to baseline conditions (Tables 7-27a, 7-27b, 7-27c, and 7-27d). Reduced exposure of juvenile salmonids to these water temperatures could extend into June in the Stanislaus and Tuolumne Rivers. Little or no change is predicted to occur in the frequency of water temperatures exceeding 59°F during summer and fall (June–October). Therefore, exposure of juvenile salmonids to water temperatures associated with increased disease risk in the Stanislaus, Tuolumne, and Merced Rivers, and LSJR would be substantially reduced during the spring rearing and outmigration period. Adverse impacts would be less than significant.

Impact AQUA-12: Changes in southern Delta and estuarine habitat resulting from changes in SJR inflows and export effects

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project Alternative technical analysis.

LSJR Alternatives

Alteration of timing and magnitude of freshwater inflows in combination with export pumping has substantially altered flow patterns in the Delta, resulting in both direct losses of fish through entrainment at the CVP and SWP export facilities, and indirect losses through changes in survival associated with altered migration patterns and habitat quality. Estuarine fishes such as delta smelt are particularly sensitive to these alterations, especially in years when spawning takes place in the southern and central Delta where a large proportion of the population (adults, larvae, and juveniles) may be subject to entrainment. Although capable of directed swimming, juvenile salmonids may also be adversely affected by altered hydrodynamics associated with low flows and relatively high rates of export pumping that result in net flows toward the pumps. These changes can also affect the magnitude of Delta outflow and the position of the low salinity zone (measured by X2), which have been shown to be correlated with the distribution and abundance of a number of estuarine fishes and their food resources.

This assessment examines potential changes in fish entrainment risk and estuarine habitat conditions resulting from changes in SJR inflows and export pumping under LSJR Alternatives 2, 3, and 4, as compared to baseline conditions. As described in Appendix F.1, *Hydrologic and Water Quality Modeling,* Section F.1.2, *Water Supply Effects Modeling—Methods*, the WSE model does not include the Delta. Therefore, potential changes in export pumping and outflow were approximated based on changes in modeled monthly flows in the SJR at Vernalis and application of a number of federal and state rules or objectives currently governing Delta operations (Table F.1.7-1 in Appendix F.1). These rules or objectives include monthly restrictions on export pumping rates, export to inflow ratios, and negative flows in Old and Middle River (OMR) to minimize the risk of entrainment and improve net downstream flows during the primary spawning and early rearing period of delta smelt (December–June) and the primary smolt migration period for SJR Chinook salmon and steelhead (April–May). Although this approach does not fully represent the complexities of Delta water management operations, it was considered a reasonable approach for assessing the relative magnitude of potential changes in fish entrainment and estuarine habitat conditions associated with the LSJR alternatives.

LSJR Alternative 2 (Less than significant)

Based on the WSE modeling results and application of several rules and objectives currently governing Delta operations (see Appendix F.1, *Hydrologic and Water Quality Modeling*), LSJR Alternative 2 is not expected to substantially change export pumping rates relative to baseline conditions. Average pumping rates in December–June when juvenile salmonids and other Delta fish species are most likely to be exposed to potential entrainment effects would be similar to baseline levels in December–May and increase by 216 cfs in June (Table F.1.7-3E). These changes represent less than 5 percent of average SJR flows and therefore would have very small effects on Delta outflow and the position of X2. Although increased export pumping in June represents a potential increase in entrainment risk for larval and juvenile fish, concurrent increases in spring SJR flows (averaging +468 cfs in May and +431 cfs in June) and Delta outflow (averaging +433 cfs in May and +216 cfs in June) (Table F.1-.7-3D and Table F.1.7-3F) represent positive effects on larval/juvenile transport and estuarine habitat conditions. In addition, continued compliance with current restrictions on export pumping rates, export to inflow ratios, and OMR flows would be expected to minimize potential impacts on juvenile salmonids and other Delta fish species during these months. Therefore, potential adverse impacts resulting from changes in Delta operations on fish entrainment and estuarine habitat conditions under LSJR Alternative 2 would be less than significant.

LSJR Alternative 3 (Less than significant)

Under LSJR Alternative 3, average pumping rates in December–June when juvenile salmonids and other Delta fish species are most likely to be exposed to potential entrainment effects would be expected to decrease in December–March (-8 to -147 cfs) and increase in April–June (+50 to +801 cfs) relative to baseline conditions (Table F.1.7-4B). Although increased export pumping in April–June represents a potential increase in entrainment risk for larval and juvenile fish, concurrent increases in spring SJR flows (averaging +810 to +2,400 cfs) and Delta outflow (averaging +761 to +2,102 cfs) (Table F.1.7-4A and Table F.1.7-4C) represent positive effects on larval/juvenile transport and estuarine habitat conditions. In addition, continued compliance with current restrictions on export pumping rates, inflow/export ratios, and OMR flows would be expected to minimize potential impacts on juvenile salmonids and other Delta fish species during these months. Therefore, potential adverse impacts resulting from changes in Delta operations on fish entrainment and estuarine habitat conditions under LSJR Alternative 3 would be less than significant.

LSJR Alternative 4 (Less than significant)

Under LSJR Alternative 4, average pumping rates in December–June when juvenile salmonids and other Delta fish species are most likely to be exposed to potential entrainment effects would be expected to decrease in December and January (-135 cfs and -217 cfs) and increase in February–June (+252 to +1,766 cfs) relative to baseline conditions (Table F.1.7-5B). Although increased export pumping in February–June represents a potential increase in entrainment risk for larval and juvenile fish, concurrent increases in spring SJR flows (averaging +586 to 5,149 cfs) and Delta outflow (averaging +293 to 4,260 cfs) (Table F.1.7-5A and Table F.1.7-5C) represent positive effects on larval/juvenile transport and estuarine habitat conditions. In addition, continued compliance with current restrictions on export pumping rates, inflow/export ratios, and OMR flows would be expected to minimize potential impacts on juvenile salmonids and other Delta fish species during these months. Therefore, impacts resulting from changes in Delta operations on fish entrainment and estuarine habitat conditions under LSJR Alternative 4 would not be adverse and would be less than significant.

7.4.4 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows in the extended plan area, as described in Chapter 5, *Surface Hydrology and Water Quality*, could potentially impact aquatic biological resources in upstream reservoirs on the Stanislaus and Tuolumne Rivers differently in the extended plan area than described in the plan area. The upstream reservoirs on the Stanislaus and Tuolumne Rivers may experience substantial changes in reservoir volume, which are not experienced by the rim reservoirs in the plan area, especially under drought conditions under LSJR Alternative 3 and LSJR Alternative 4 with or without adaptive implementation. This different potential impact occurs because reservoirs in the extended plan area reservoirs are smaller than the downstream rim reservoirs, which could magnify individual changes. Furthermore, required bypass flows may reduce opportunity for these reservoirs to refill once they are drawn down. Reservoir drawdown could reduce the area and volume of water available for in-reservoir aquatic habitat affecting aquatic species including fish. In addition, water temperature in the upstream reservoirs could increase due to lower storage. As a result, the temperature of the water entering the rim dam reservoirs could increase, although an increase in volume of the rim reservoirs resulting from bypassed upstream flows could help maintain cool temperatures in these reservoirs.

Under LSJR Alternative 2 with adaptive implementation or LSJR Alternative 3 with or without adaptive implementation, the type and scale of impacts on aquatic species during individual reservoir drawdown events would be similar to what is experienced during baseline reservoir operations (USGS Reservoir Gage Data). Additionally, these reservoirs might refill during the subsequent wet season, limiting the duration of reduced reservoir elevations if no water supply shortage is forecast for the upcoming year. In the most extreme cases, during drought years and years with substantial increases in bypass flows in the extended plan area particularly under LSJR Alternative 3 and LSJR Alternative 4 with or without adaptive implementation, some reservoirs might be drawn down more quickly, to lower levels, and for longer periods of time than under baseline conditions. If these conditions occurred there would be an adverse impact on aquatic species because the reservoir habitat would be greatly reduced when compared to baseline conditions.

Changes in river flows on the Stanislaus, Tuolumne, and Merced Rivers as described in Chapter 5, *Surface Hydrology and Water Quality*, would result in similar impacts on aquatic resources described for the plan area. An increase in flow would not result in adverse impacts on aquatic species. However, flows in the extended plan area could decrease in the fall relative to baseline under the LSJR alternatives with or without adaptive implementation; such an outcome is not anticipated in the plan area. This could result in reduced habitat for aquatic species. In addition, during drought conditions, particularlyunder LSJR Alternative 3 and LSJR Alternative 4 with or without adaptive implementation, substantial reservoir volume reductions could occur. Under these conditions there is potential for warmer water to be released from reservoirs, which would adversely impact downstream water temperature and aquatic resources. Furthermore, if low reservoir volumes result in low reservoir carryover volumes, these temperature impacts could be increased.

The increased frequency of lower reservoir levels and potential reduction in river flow in the fall resulting from the LSJR alternatives, however, would be limited by the program of implementation under each of the LSJR alternatives. The program of implementation requires minimum reservoir carryover storage targets or other requirements to help ensure that providing flows to meet the flow objectives will not have adverse temperature or other impacts on fish and wildlife or, if feasible, on other beneficial uses. Other requirements, for example, include, but are not limited to, limits on required bypass flows for reservoirs that store water only for nonconsumptive use so that some water can be temporarily stored upstream. The program of implementation also states that the State Water Board will take actions as necessary to ensure that implementation of the flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods. Accordingly, when the State Water Board implements the flow objectives in a water right proceeding, it will consider impacts on fish, wildlife, and other beneficial uses and health and safety needs, along with water right priority. Until the State Water Board assigns responsibility to meet the flow objectives in the Bay-Delta Plan, it is speculative to identify the exact extent, scope, and frequency of reduced diversions, reduced reservoir levels and their effects on fish, in the extended plan area. When implementing the flow objectives, the State Water Board would identify project-specific impacts and avoid or mitigate, to the extent feasible, significant impacts of lower reservoir levels on aquatic species habitat and temperatures in accordance with CEQA.

At the time of preparation of this programmatic analysis, it is unclear to what extent any significant impacts could be fully mitigated to aquatic species due to a reduction in reservoir storage. Thus, the potential exists for significant impacts. Therefore, this analysis conservatively concludes that impacts associated with lower reservoir levels under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation are significant. The following mitigation measure is proposed: when considering carryover storage and other requirements to implement the flow water quality objectives in a water right proceeding, the State Water Board shall ensure that reservoir levels upstream of the rim dams do not cause significant fish and wildlife impacts, unless doing so would be inconsistent with applicable laws. The impact is considered significant, even with mitigation, because the mitigation may not fully mitigate the impact in all situations.

7.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 8
Terrestrial Biological Resources

8.1 Introduction

This chapter describes the environmental setting for terrestrial biological resources and the regulatory background associated with these resources. It also evaluates environmental impacts on terrestrial biological resources that could result from the Lower San Joaquin River (LSJR) alternatives, the significance of any impacts, and, if applicable, offers mitigation measures that would reduce significant impacts. A discussion of aquatic biological species and habitat (e.g., fish and their spawning and rearing areas) is presented in Chapter 7, *Aquatic Biological Resources*.

The Southern Delta Water Quality (SDWQ) alternatives would not affect terrestrial biological resources. As summarized in Section 8.4.2, *Methods and Approach*, the SDWQ alternatives would not result in a change in the water quality at Vernalis and, therefore, would not result in a change from baseline conditions. As discussed in Chapter 5, *Surface Hydrology and Water Quality,* and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta,* it is not expected that salinity within the southern Delta would exceed historical monthly salinity levels, which range between 0.2 deciSiemens per meter (dS/m) (0.134 parts per thousand [ppt]) and 1.2 dS/m, (0.768 ppt), which are levels that terrestrial species can tolerate. As such, the SDWQ alternatives are not expected to result in significant adverse modifications to existing terrestrial habitat or result in impacts on plant and animal species and are not analyzed in detail in this chapter. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on biological resources. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

As described in Chapter 1, *Introduction*, the plan area generally includes those portions of the San Joaquin River (SJR) Basin that drain to, divert water from, or otherwise obtain beneficial use (e.g., surface water supplies) from the three eastside tributaries[1] of the LSJR. These include the Stanislaus River from and including New Melones Dam and Reservoir to its confluence with the LSJR; the Tuolumne River from and including New Don Pedro Dam and Reservoir to its confluence with the LSJR; the Merced River from and including New Exchequer Dam and Lake McClure to its confluence with the LSJR; and, the SJR between its confluence with the Merced River and downstream to Vernalis (i.e., LSJR). Within the plan area, there is a designated area of potential effects for terrestrial biological resources (including riparian habitats) for the LSJR alternatives. For the three large reservoirs, this area of potential effects is defined as the *zone of fluctuation*. While the smaller reservoirs that exist downstream of the rim dams[2] also contain habitat for terrestrial biological resources, including wetland and riparian habitat, the LSJR alternatives are not expected to adversely affect those waterbodies as they are used to regulate flows released from the upstream

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[1] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[2] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

dams and would release any increased flow downstream. For the three eastside tributaries and the LSJR, the area of potential effects includes the areas adjacent to these channels that are affected by the existing flows or the flows that would result from the LSJR alternatives (e.g., riparian vegetation). This area includes the bankfull channel below the floodplain and the inundated areas adjacent to the main channel. Within the plan area, there is also an area of potential indirect effects for terrestrial biological resources. This area of potential indirect effects includes undeveloped and agricultural areas outside of riparian and reservoir areas since this area could experience potential changes in agricultural uses or land cover as a result of potential reduced irrigation water supply.

The extended plan area, also described in Chapter 1, generally includes the area upstream of the rim dams. The area of potential effects for this area is similar to that of the plan area and includes the zone of fluctuation around the numerous reservoirs that store water on the Stanislaus and Tuolumne Rivers. (The Merced River does not have substantial upstream reservoirs that would be affected.) It also includes the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Resources Control Board (State Water Board) determined whether the plan amendments[3] would cause any adverse impact for each environmental category in the checklist in Appendix B and provided a brief explanation for its determination. Impacts that are listed as "Potentially Significant Impacts" are discussed in detail in this chapter. In addition, as discussed in Appendix B, the State Water Board determined that additional types of potential adverse impacts that are not listed in the checklist should be evaluated. Accordingly, this chapter evaluates potential impacts not initially listed in the checklist, but that have been identified in this chapter as potentially significant. Specifically, whether the LSJR alternatives could have a substantial adverse effect on native terrestrial species by increasing the distribution and abundance of invasive plants and nonnative wildlife species in the plan area. Appendix B identified the LSJR alternatives as having a potentially significant impact on aquatic biological resources and terrestrial biological resources because changes in flow requirements may result in changes in river volume or rates, or reservoir water surface elevation fluctuations and may have indirect effects associated with potential changes in agricultural uses or land cover. The potential impacts on terrestrial biological resources are described in this chapter, whereas the potential impacts on aquatic biological resources are discussed in Chapter 7.

LSJR Alternatives 2, 3, and 4 could affect reservoir operations in the Stanislaus, Tuolumne, and Merced Rivers and, therefore, changes in the flows in each of these tributaries, the LSJR, and Delta, resulting in potential impacts on terrestrial biological resources. The comparison of monthly cumulative distributions of flows, in conjunction with the individual monthly average changes in flow, provides an appropriate measure of hydrologic changes resulting from the LSJR alternatives. For the three large reservoirs, the rates of reservoir fluctuations from month to month are compared between baseline and the LSJR alternatives. This information is then used to evaluate the expected type of terrestrial habitat conditions under baseline and LSJR alternative conditions.

The potential impacts of the LSJR alternatives on terrestrial biological resources are summarized in Table 8-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3 and 4 each include four methods of adaptive implementation. This recirculated substitute environmental

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[3] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 8-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*. Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to actions and methods of compliance.

Table 8-1. Summary of Terrestrial Biological Resources Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact BIO-1: Have a substantial adverse effect on any riparian habitat or other sensitive natural terrestrial communities identified in local or regional plans, policies, or regulations or by the California Department of Fish and Wildlife (CDFW) or United States Fish and Wildlife Service (USFWS)			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Significant	NA
LSJR Alternatives 2, 3, and 4	The change in median monthly flows or overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would not substantially effect riparian habitat or other sensitive terrestrial communities because the plants located within the area of potential effects can survive inundation, are resistant to the effects of scouring and deposition, and are limited by water availability. Fluctuations in reservoir elevations would not be substantially different than those that currently occur. Therefore, the LSJR alternatives would not have significant adverse effects on riparian or wetland habitats or other sensitive terrestrial communities around the reservoirs.	Less than significant	Less than significant
Impact BIO-2: Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrologic interruption, or other means			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Significant	NA
LSJR Alternatives 2, 3, and 4	Monthly median flows or the cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would generally increase. Increased flow would not adversely affect wetland communities because wetland plants can survive inundation, are resistant to the effects of scouring and deposition, and are growth-limited by water availability. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of the LSJR Alternatives 2, 3, and 4, therefore adverse effects are not expected to occur on wetland communities surrounding the reservoirs. Therefore, substantial adverse effects on wetland communities would not occur.	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact BIO-3: Facilitate a substantial increase in distribution and abundance of invasive plants or nonnative wildlife that would have a substantial adverse effect on native terrestrial species			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	Changes in flows in the LSJR and the three eastside tributaries and fluctuations in reservoir elevations may result in alteration of vegetation patterns in specific locations, but there is no basis to suggest increased flows would substantially increase the distribution and abundance of invasive plant species. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of the LSJR Alternatives 2, 3, and 4. In addition, the potential for invasive plants and nonnative wildlife species to increase due to a reduction in irrigation water supply availability or potential fallowing would not be expected to exceed existing levels because some agricultural lands would be farmed less intensively, fallowed lands can retain growth, and existing invasive species programs would continue to be implemented. Therefore, an increase in the distribution and abundance of invasive plants or nonnative wildlife is not expected to result from implementation of the LSJR alternatives.	Less than significant	Less than significant
Impact BIO-4: Have a substantial adverse effect, either directly or through habitat modifications, on any terrestrial animal species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW or USFWS			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Significant	NA
LSJR Alternatives 2, 3, and 4	Most of the special-status animal species present in the area of potential effects are dependent on riparian habitat. As described above for Impact BIO-1, there would not be a substantial change to available riparian habitat. Similarly, the frequency and range in reservoir elevation fluctuation are not expected to change substantially compared to the baseline conditions, consequently, adverse effects are not expected to occur to special-status species or their habitat at the reservoirs. A potential reduction in irrigation water supply in the area of potential indirect effects would not have a substantial adverse effect on special status species due to indirect habitat	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	modification because agricultural land cover would not necessarily be fallowed in perpetuity, as lands could be dryland farmed, deficit irrigated, or rotated. This could result in less agricultural intensive practices on some lands. The resulting halt of mechanized agriculture, pesticide and rodenticide application, and anthropogenic disturbance as a result of less agricultural intensive practices is unlikely to result in a substantial adverse effect on sensitive or special-status species. The potential reduction of monocultural irrigated crops is likely to support the species and ecosystem recovery strategy outlined in the USFWS recovery strategy. Therefore, it is not expected that special-status animal species would be adversely affected.		
Impact BIO-5: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan or conflict with any local policies or ordinances protecting biological resources			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternatives 2, 3, and 4	The change in median monthly flows or overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR and changes to the range and/or frequency in reservoir fluctuation would not substantially affect riparian habitat or other sensitive terrestrial communities or the special-status animal species dependent on them (Impact BIO-1and Impact BIO-4). In addition, it is expected that wildlife refuges would continue to receive surface water, as needed, and continue to implement existing water management plans. Therefore, impacts on habitat value would not occur and there would not be a potential to conflict with plans protecting biological resources.	Less than significant	Less than significant

NA = not applicable

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 8.4.2, *Methods and Approach*, of this chapter.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in continued implementation of flow objectives and salinity objectives established in the 2006 Bay–Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion, and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

8.2 Environmental Setting

The Upper SJR flows north through the San Joaquin Valley, a geologic trough between the Coast Ranges to the west and the Sierra Nevada to the east. It is joined by the three eastside tributaries, which convey surface runoff (rain and snow melt) from the Sierra Nevada to the LJSR. The freshwater from the LSJR enters the Delta where it eventually joins the Sacramento River, and the combined rivers flow west through the Carquinez Strait into the San Francisco Bay, along the way mixing with ocean saltwater to create unique and diverse semi-aquatic and terrestrial ecosystems.

Together, the LSJR and the Delta serve as an important habitat to more than 750 animal and plant species (CDFW 2014a). Once a vast system of wetlands and uplands, the LSJR and Delta have been transformed by over 100 years of levee building into a maze of interconnected waterways and low, reclaimed islands (CDFW 2014a). Dams and water diversions have impaired river flow and modified inundation regimes. CDFW (2014a) estimates that less than 10 percent of the historical wetland acreage and less than 2 percent of the historical riparian acreage currently remains in the San Joaquin Valley.

The State Water Board performed a literature review to characterize the terrestrial biological resources in and around the area of potential effects for the LSJR and southern Delta. Information was gathered and reviewed to identify and describe special-status plant and wildlife species that are known to exist, could potentially exist, or historically existed in the area of potential effects. For the purpose of this document, special-status species were defined as follows.

- Species listed, species proposed for listing, or candidates for possible future listing as threatened or endangered under the Endangered Species Act (ESA) (16 U.S.C., § 1531 et seq.) or California Endangered Species Act (CESA). (Fish & G. Code, § 2050 et seq.)
- Plant species designated as rare under the California Native Plant Protection Act. (Fish & G. Code, § 1900 et seq.)
- Plant species considered by the California Native Plant Society (CNPS) to be "rare, threatened, or endangered in California" (Rare Plant Rank 1B and 2).
- Wildlife species considered species of special concern by the California Department of Fish and Wildlife (CDFW) (formerly the California Department of Fish and Game).
- Wildlife species designated as "fully protected species" by CDFW. (Fish & G. Code, §§ 3511, 4700, 5050 and 5515.)

Information on special-status plant and wildlife species was compiled through a review of the following sources.

- CNPS Inventory of Rare and Endangered Plants of California, 2012.
- California Natural Diversity Database (CNDDB), 2011–2012.
- U.S. Fish and Wildlife Service (USFWS) Federal Endangered and Threatened Species Lists for the region, 2011.

8.2.1 LSJR and the Three Eastside Tributaries

This section describes the area of potential effects and the area of potential indirect effects of the LSJR alternatives within the LSJR and the three eastside tributaries on terrestrial resources. Flows would affect vegetation within the immediate area of the rivers and are not expected to affect vegetation or habitat outside the riparian corridor. The area of potential effects includes the channels of the three eastside tributaries to the LSJR and the LJSR, including the areas adjacent to these channels that are affected by the existing flows or the LSJR alternative flows (e.g., riparian vegetation). This includes the bankfull channel below the floodplain (Figures 8-1a and 8-1b). The area of potential indirect effects includes undeveloped and agricultural land cover in the plan area which could experience a reduction in irrigation water supply.

Snowmelt runoff and seasonal rainfall from the Sierra Nevada mountain range are the major sources of water to the SJR and the three eastside tributaries. As a result, peak flows historically occurred in May and June. Natural overbank flooding distributed higher flows outside the main river channel(s) into a complex network of sloughs, which supported large patches of riparian forest and tule marshes. This overland flooding resulted in several thousands of acres of permanent tule marsh and more than 1.5 million acres of seasonally flooded wetlands and native grasslands (CALFED 2000). The natural levees and floodplains formed by these processes supported as many as 2 million acres of large, diverse riparian forests (CDFW 2014a). The LSJR and three eastside tributaries are now largely confined within constructed levees in many locations and bounded by agricultural and urban development. Flows are regulated through dams and water diversions, and floodplain habitats have been fragmented and reduced in size and diversity (USBR 2011a).

Federal, state, and local efforts to preserve existing habitat functions have resulted in the establishment of multiple national wildlife refuges and other wildlife areas, which receive water from the LSJR and the three eastside tributaries. Figure 8-2 shows the location of the national wildlife refuges and the other wildlife areas and Table 8-2 summarizes characteristics of these refuges and areas.

Flow and sediment regulation, through the development of the rim dams and increased water diversions, have been implicated as factors in the decline of riparian communities, both in general and specifically on the LSJR and three eastside tributaries (Capon and Dowe 2006; CDFG 2007; TID and MID 2011). Flow regulation has created artificially stable inter- and intra-annual hydrologic conditions, resulting in decreased peak flows, increased summer base flows, and a reduction of physical processes, such as scour and sediment deposition (Stillwater Sciences 2003a). Modified hydrologic and fluvial processes influence riparian vegetation establishment, survival, and succession. The near elimination of large floods and the corresponding scouring flows that remove vegetation have allowed some riparian habitat to mature into dense, even-aged stands, which impoverishes community structure and reduces sapling recruitment (TID and MID 2011; USBR 2011b). Elimination of floods also has allowed riparian scrub and trees to establish themselves in channels and gravel bars, which anchors substrates that typically are rearranged with every high flow event (TID and MID 2011; USBR 2011b). This evolution has contributed to simplification of channel morphology and loss of channel margins (TID and MID 2011).

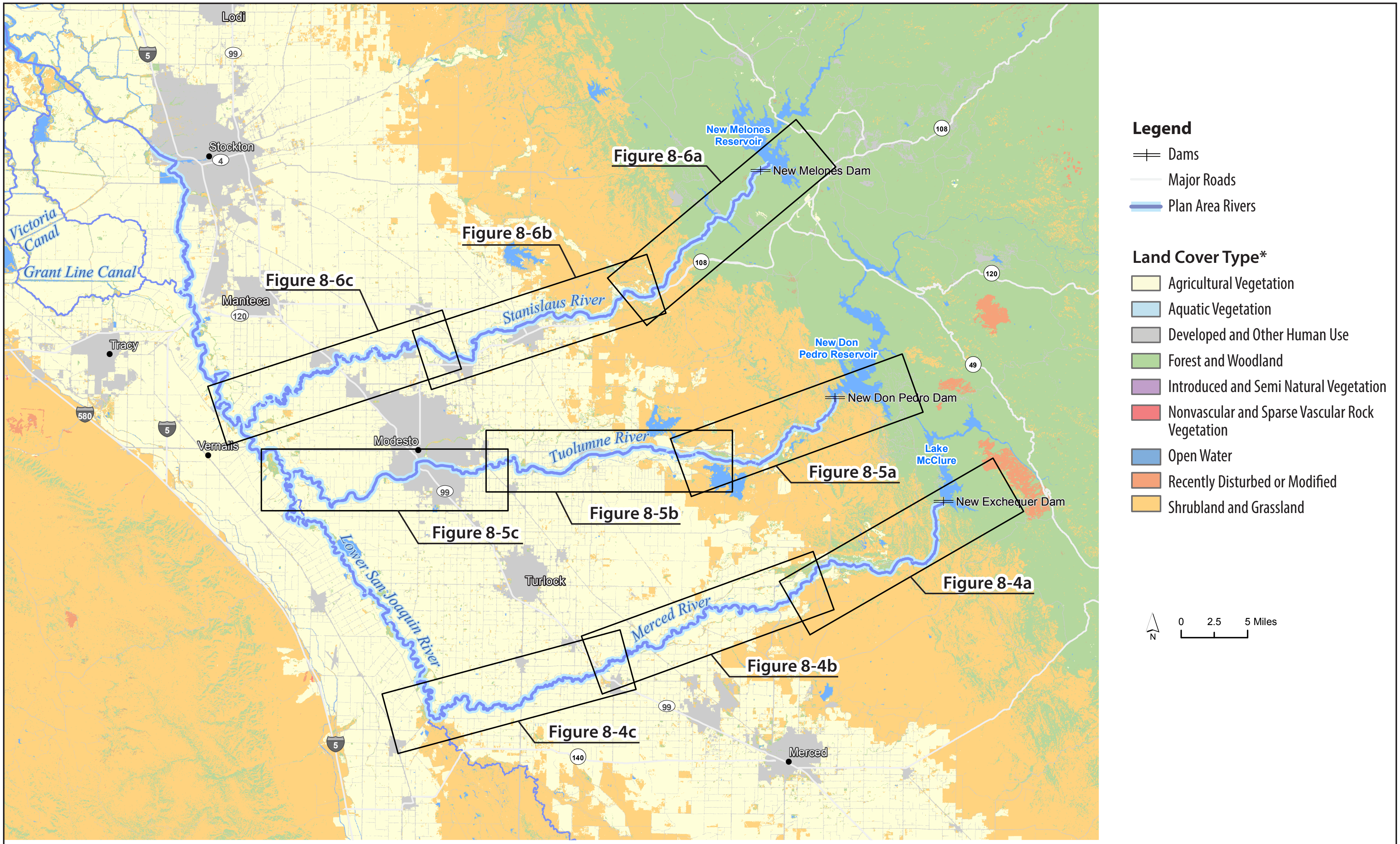
* Land Cover Type Source: USGS Gap Analysis Program: Land Cover, U.S. Department of the Interior U.S. Geological Survey

URL: http://gapanalysis.usgs.gov/index.php

Reservoirs are representative of full-reservoir conditions.

Graphics...00427.11 (3-1-2016)

Figure 8-1a
Lower San Joaquin River Land Cover



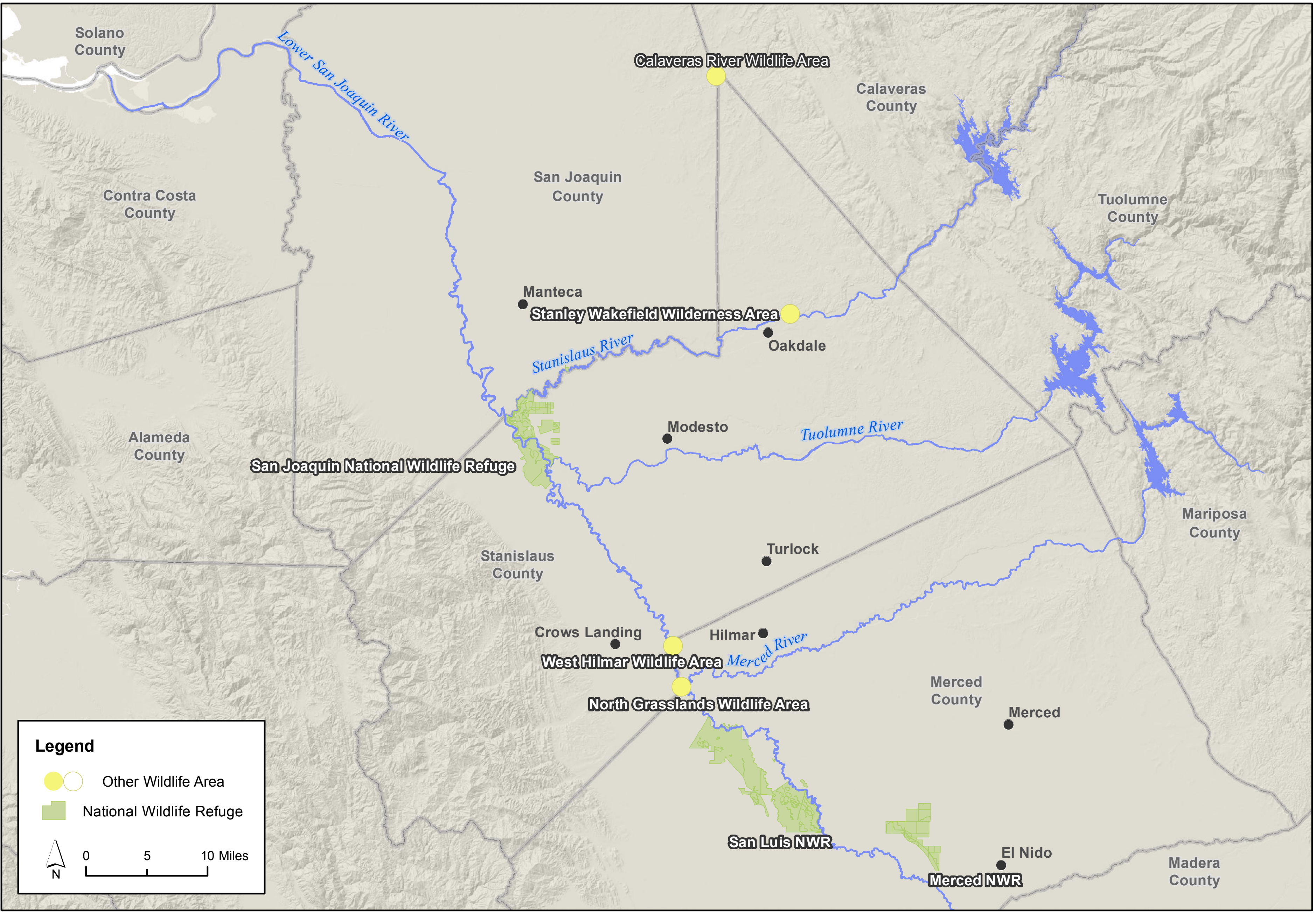
* Land Cover Type Source: USGS Gap Analysis Program: Land Cover, U.S. Department of the Interior U.S. Geological Survey

URL: http://gapanalysis.usgs.gov/index.php

Reservoirs are representative of full-reservoir conditions.

Graphics...00427.11 (3-1-2016)

Figure 8-1b
Merced, Tuolumne, and Stanislaus Rivers Land Cover



Path: K:\Projects_2\SWRCB\00427_11_SJ_River\mapdoc\Fig_8_2_NationalWildlifeRefuges_and_Other_20160301.mxd; User: 25110; Date: 3/1/2016

Figure 8-2
National Wildlife Refuges and Other Wildlife Areas

Table 8-2. Summary of National Wildlife Refuges and Other Wildlife Areas

Location/ Size (acres[a])	General Characteristics, Including Habitat Types	Identified Wildlife	Surface Water Source(s)	Other Water Source(s) and Information Regarding Water Supply
North Grasslands Wildlife Area				
Merced County (7,400 acres)	Restored and created wetlands, riparian habitat, and uplands. The wildlife area is comprised of three non-contiguous units: (1) China Island Unit (to the east of Newman and Gustine), (2) Salt Slough Unit (Volta), and (3) Gadwall Unit (Los Baños)	Swainson's hawk, Sandhill crane, duck, pheasant, dove.	The China Island Unit receives the majority of its water from USBR and Central California Irrigation District (CCID) cooperative agreements (CDFG 2011a). Specifically, federal L2 and L4[b] contract for 6,967 and 3,483 acre-feet/year (AF/y), respectively (CDFG 2011b). The Salt Slough Unit receives federal L2 and L4 water (6,680 and 3,340 AF/y, respectively) from Grasslands Water District. The Salt Slough Unit also receives water via the following sources: (1) Appropriative (Contract A0145582), 13,500 AF/y, from Salt Slough; (2) Appropriative (Contract A013508) 3 cubic feet per second (cfs) from Salt Slough; and (3) Other, riparian, (Statement S009611), 30 cfs from Salt Slough (CDFG 2011b). Frequently, federal L2 and L4 contracted water cannot be delivered due to maintenance or other issues such as constraints due to mosquito abatement issues (CDFG 2011a). The Gadwell Unit receives water through the Central Valley Project Improvement Act (CVPIA) (Central Valley Joint Venture 2006).	The China Island and Salt Slough Units have groundwater wells, which provide a valuable source of water during drought periods (CDFG 2011a, 2011b). Although, these wells do not meet all water needs of refuge, policies are in place to support pooling of water supplies,[c] water transfers, water reallocations or exchanges of water to meet the needs of these wildlife areas (CDFG 2011a and 2011b). The Gadwall Unit has a groundwater well (USBR 2014 and USBR 2105a).
Stanley Wakefield Wilderness Area				
Stanislaus County (14 acres)	Kerr Community Park	Unknown recorded wildlife	There is no record of water rights or statements that serve this wildlife area (State Water Board 2016). As such, this refuge is likely served by available water in the Stanislaus River.	Assumed no other water supply besides Stanislaus River.

Location/ Size (acres^a)	General Characteristics, Including Habitat Types	Identified Wildlife	Surface Water Source(s)	Other Water Source(s) and Information Regarding Water Supply
West Hilmar Wildlife Area				
Merced County (340 acres)	Oak and cottonwood woodlands and grasslands	Great blue heron, egret, waterfowl, quail, and pheasant	There is no record of water rights or statements that serve this wildlife area (State Water Board 2016). As such, this refuge is likely served by available water in the LSJR.	Assumed no other water supply besides the LSJR.
Calaveras River Wildlife Area				
San Joaquin County (24 acres)	Lower Calaveras-Mormon Slough Watershed unknown	Unknown recorded wildlife	There is no record of water rights or statements that serve this wildlife area (State Water Board 2016). As such, this refuge is likely served by available water in the river. Conservation easement held by CDFW.	Assumed no other water supply besides river.
San Joaquin River National Wildlife Refuge				
Stanislaus and San Joaquin Counties (7,000 acres)	Riparian woodlands, wetlands, grasslands, cropland, irrigated pasture, fallow, and vernal pools	Swainson's hawk, heron, cormorant, and riparian brush rabbit	San Joaquin River National Wildlife Refuge has two appropriative rights and one riparian right. These rights supplied water to the portion of the refuge purchased from El Soyo Dairy. There are also one appropriative and three riparian rights on lands within the refuge boundary that are not owned by USFWS. Modesto Irrigation District (MID) supplies water to the western portions of the refuge. Water used east of the SJR is provided by the privately owned Mapes Ranch. (USFWS 2006.) A total of 19,440 AF/y is needed for the refuge (USFWS 2006). This refuge does not receive CVPIA/Central Valley Project (CVP) water (USFWS 2006).	Groundwater wells are present on the refuge (USFWS 2006).

Location/ Size (acres[a])	General Characteristics, Including Habitat Types	Identified Wildlife	Surface Water Source(s)	Other Water Source(s) and Information Regarding Water Supply
Merced National Wildlife Refuge				
Merced County (10,000 acres)	Over 150 individual wetland units or ponds are managed and contain wetlands, native grasslands, vernal pools, and riparian areas. The refuge is comprised of the following three units: (1) Merced Unit, (2) Arena Plains Unit, and (3) Snobird Unit	Sandhill crane, migratory waterfowl, Swainson's hawk, tricolored blackbird, burrowing owl, marsh wren, coyote, ground squirrel, desert cottontail rabbit, beaver, long tailed weasel, fairy shrimp, tadpole shrimp, and tiger salamander	The refuge receives approximately 16,000 AF/y of federal L2 water from the Merced Irrigation District (Merced ID) (USFWS 2010a). The refuge has an appropriative right for approximately 3,000 AF/y from Deadman Slough during the winter and spring, and approximately 350 AF/y during the spring and summer from Duck Slough (USFWS 2010a). The refuge receives floodwater/tailwater from Deadman Slough and Mariposa Creek/Eastside Bypass when available (USFWS 2010a). Under the "Exceptional Drought" conditions of 2015, the Merced National Wildlife Refuge received 50% or less of normal water allotments (USFWS 2016).	Groundwater wells are present on the refuge (USFWS 2010a). Drainage water is accepted from Merced ID (USFWS 2010a). The refuge follows the policies and procedures on pooling, transfers, reallocations, and exchanges for those established by the CVPIA and in water supply contracts.
San Luis National Wildlife Refuge				
Merced County (29,000 acres)	Wetlands, riparian forests, native grasslands, vernal pools, and uplands (irrigated pasture, croplands, non-irrigated pasture). The refuge is comprised of the following three areas: (1) East of Highway 165, (2) East Bear Creek, and (3) West of Highway 165	California tiger salamander, long-horned fairy shrimp, San Joaquin kit foxes, Tule Elk, green-winged teals northern shoveler, mallard, gadwall, wigeons cinnamon teal, northern pintail, ring-necked duck, canvasback, ruddy duck, snow goose, Ross' goose, white-fronted goose, coot, grebe, blackbird, bittern, dunlin, long-billed dowitcher, least sandpiper, western	The refuge receives federal L2 and L4 water from the San Luis Canal Company, Stevenson Water District, Merced ID, and Grasslands Water District (USFWS 2010b). The L2 water totals approximately 50,000 AF/y, depending on the water suppliers and contracts. The L4 water totals approximately 8,000 AF/y depending on availability from Grasslands Water District (USFWS 2010b). The refuge also has an appropriative right to approximately 20,000 AF/y from Salt Slough (USFWS 2010b). The refuge has floodwater-passive riparian rights from the SJR, and a riparian diversion from Bear Creek, as available (USFWS 2010b). Under the "Exceptional Drought" conditions of 2015, San Luis National Wildlife Refuge received 50 percent or less of normal water allotments (USFWS 2016).	Appropriative sources, groundwater and drainwater provide most of the water supply used to manage the wetlands before CVPIA (L2 and L4 water) became available (USFWS 2010b). Drainage water is accepted from various sources (USFWS 2010a). The refuge follows the policies and procedures on pooling, transfers, reallocations, and exchanges for those established by the CVPIA and in water

Location/ Size (acres[a])	General Characteristics, Including Habitat Types	Identified Wildlife	Surface Water Source(s)	Other Water Source(s) and Information Regarding Water Supply
		sandpiper, long-billed curlew, heron, white-faced ibis, coyote, desert cottontail rabbit, ground squirrel, western meadowlark, yellow-billed magpie, loggerhead shrike, northern harrier, and white-tailed kite		supply contracts. Groundwater wells are present on the refuge (USFWS 2010b).

Sources: CDFG 2011a; CDFG 2011b; USBR 2014; USBR 2015a; Central Valley Joint Venture 2006; State Water Board 2016;; USFWS 2006; USFWS 2010a; USFWS 2010b; USFWS 2016.

AF/y = acre-feet per year
CCID = Central California Irrigation District
cfs = cubic feet per second
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
Merced ID = Merced Irrigation District
MID = Modesto Irrigation District
USBR = U. S. Bureau of Reclamation
USFWS = U.S. Fish and Wildlife Service

[a] Acreages are approximate.

[b] The CVPIA is described in greater detail in Section 8.3.1 *Federal [Regulatory Background]* and refers to two types of refuge water deliveries, Level 2 (L2) and Level 4 (L4). L2 represents the average annual historical water supplies received by land designated for refuges between 1975 and 1984 and L4 identifies the water supplies needed by refuges for the development of full habitat benefits. L2 water is provided primarily from CVP water supplies (USBR. 2014).

[c] Whenever maximum quantities of L2 Water Supplies and/or the Incremental L4 water supplies in a USBR contract (in the case of China Island Unit Contract #01-WC-20-1756 Exhibit B) are reduced, the remaining L2 and/or Incremental L4 Water Supplies may be pooled for use on other refugees following established rules (CDFG 2011a).

Potentially Affected Habitats

Much of the native vegetation in terrestrial habitats along the LSJR and the three eastside tributaries has been replaced by introduced species or is disturbed by cultivation, grazing, and development. The spatial extent of the river floodplains has been reduced by water management (CDFG 2007; USBR 2011b). Despite the loss of habitat associated with these activities, the rivers are generally flanked by a ribbon of riparian and wetland habitats. There is also some riparian habitat and small areas of wetland habitat around the edges of the three large reservoirs on the three eastside tributaries.

A spatial query of the CNDDB reported the following special-status habitats to be within approximately 1,000 feet (ft) of the area of potential effects: coastal and valley freshwater marsh, great valley cottonwood riparian forest, great valley mixed riparian forest, great valley oak riparian forest, and elderberry savanna. Although not reported by the CNDDB within or near the area of potential effects, other sensitive habitats in the vicinity include northern claypan and other vernal pool types, valley needlegrass grassland, serpentine bunchgrass, valley sacaton grassland, alkali flats and playas, and chenopod scrub (State Water Board 1999; CDFG 2012).

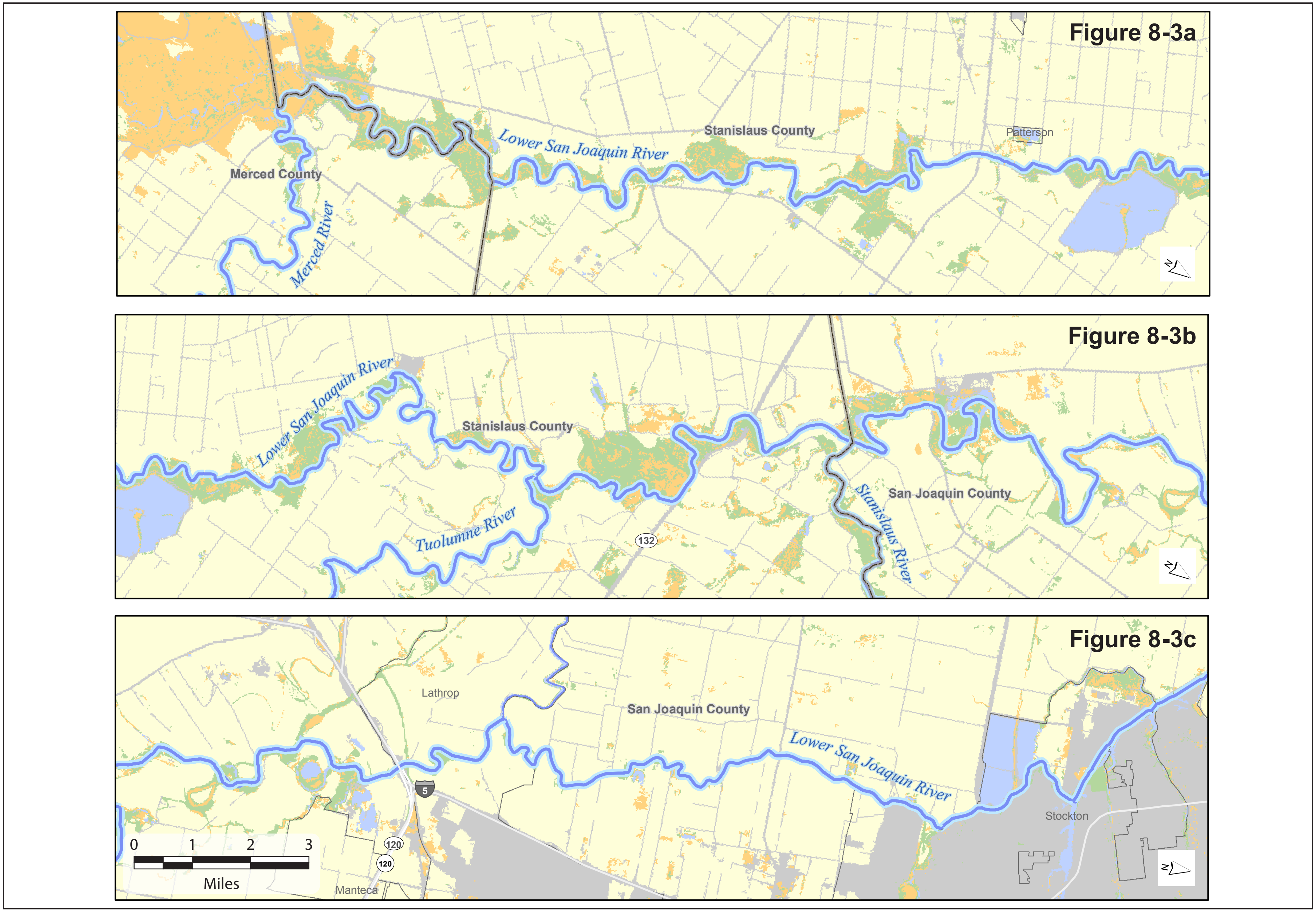
ESA defines *critical habitat* for threatened or endangered species as specific geographic areas that contain features essential for the conservation of the species and that may require special management and protection. (16 U.S.C., § 1532(5)(A).) No federally designated critical habitat is within the area of potential effects for the LSJR or SDWQ alternatives (i.e., channels). Outside the area of potential effects (areas adjacent to the main channel) on the Stanislaus and Tuolumne Rivers, are critical habitat areas designated for the California tiger salamander (*Ambystoma californiense*). There is also critical habitat designated outside the area of potential effects on the Merced River for San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*) (USFWS 2012).

The following sections describe the major vegetation communities and types of land cover in the area of potential effects. Figures 8-3, 8-4, 8-5 and 8-6 show major vegetation communities in the area of potential effect for each river. Near the water bodies, habitats are dynamic and constantly shifting in response to environmental factors, such as water chemistry and water availability. Riparian plants possess adaptations that reduce physiological stress and damage when submerged or completely exposed, such as during droughts or reservoir drawdown (Braendle and Crawford 1999; Karrenberg et al. 2002). Capon and Dowe (2006) explain:

> Plants persisting in riparian habitats usually exhibit adaptations that allow them to survive through periodic episodes of fluvial disturbance. These can be either physiological or morphological adaptations, through which plants tolerate flooding as mature individuals, or life history adaptations that enable plants to tolerate the stresses associated with flooding in time or space. . . . Furthermore, this vegetation type exists in locations that already experience wide fluctuations in water availability and wave erosion.

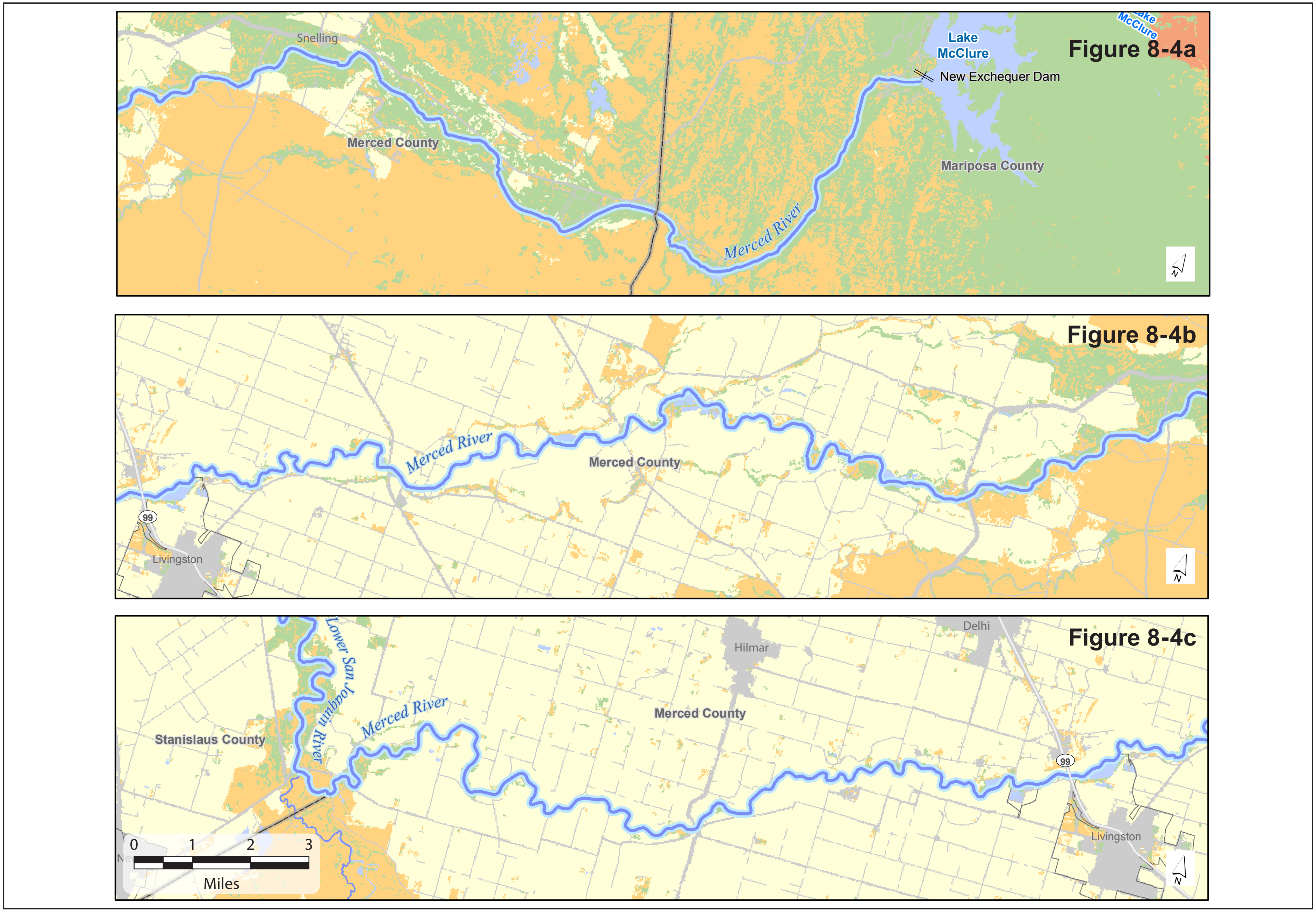
Riparian Forest

The term *riparian*, as used herein, applies to the vegetation zone and other biological resources contiguous to, and affected by, surface and subsurface hydrologic features of perennial or ephemeral rivers and streams or artificial drainage ways. Riparian forests depend on a shallow groundwater table and can survive brief periods of flooding. The nature of San Joaquin Valley riparian zones is dynamic and was historically driven by annual flooding and long summer drought. Annual flooding established a frequent disturbance regime via floodplain inundation, scour, and sediment deposition



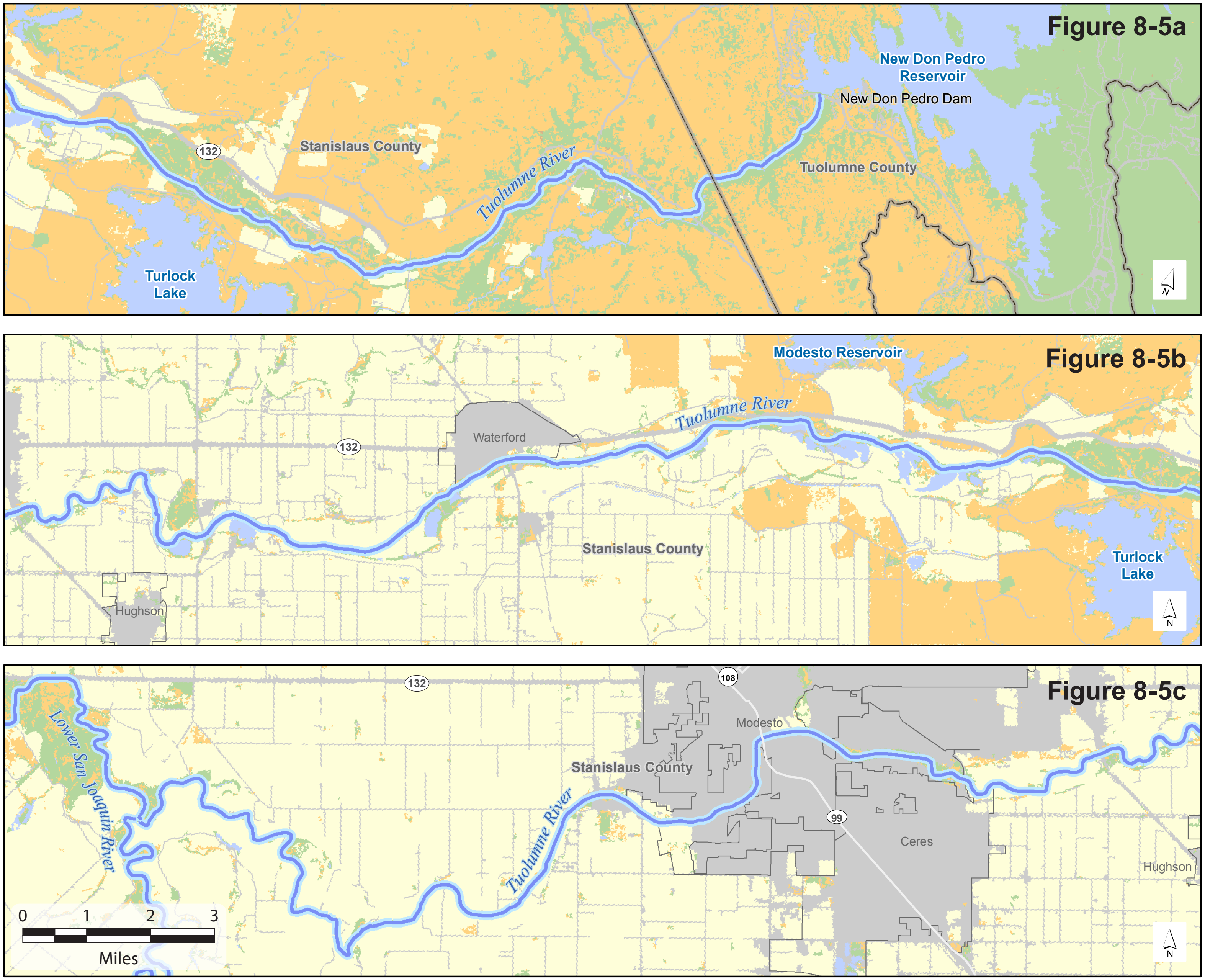
Graphics...00427.11 (3-1-2016)

Figure 8-3
Lower San Joaquin River Vegetation Communities



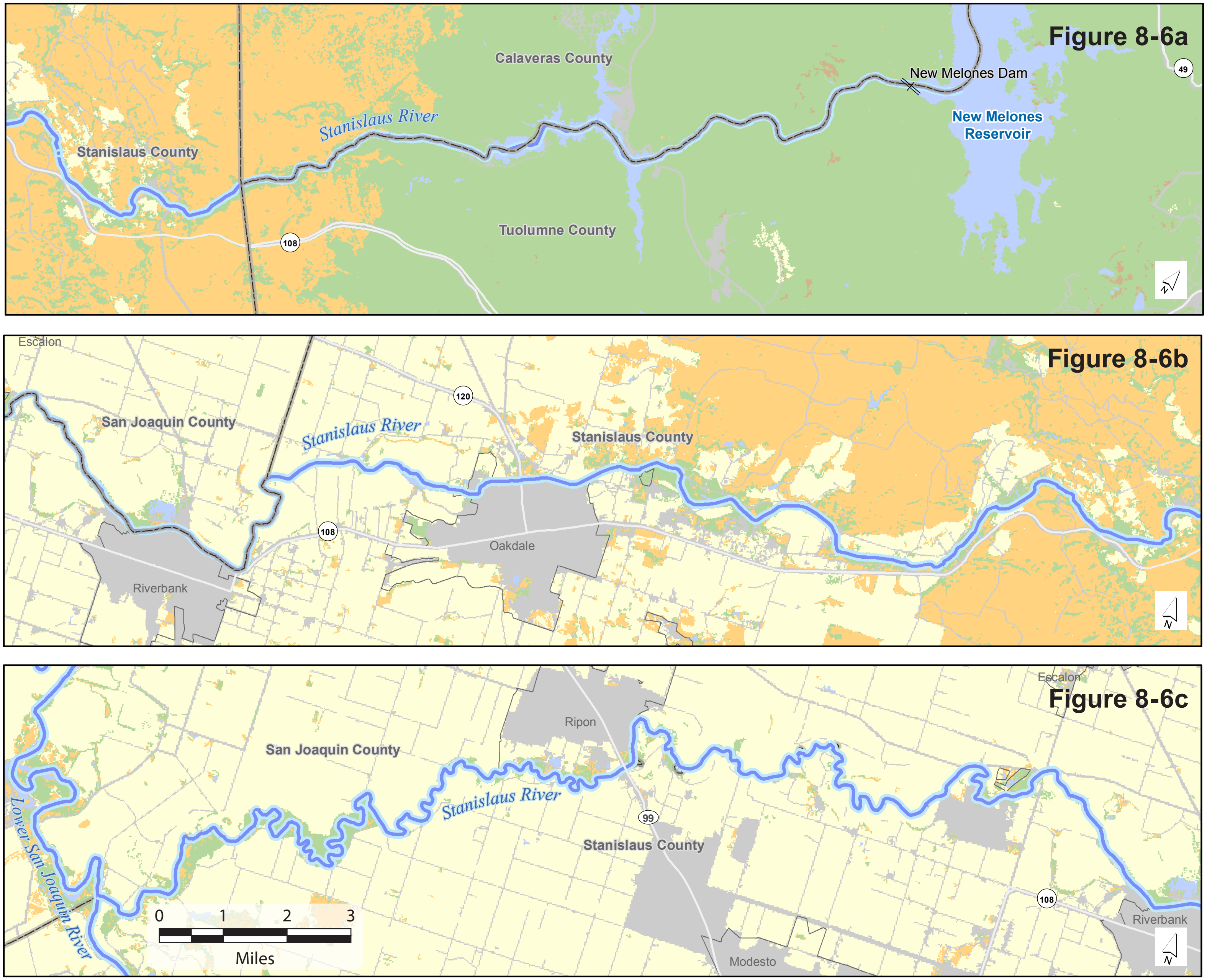
Graphics...00427.11 (3-2-2016)

Figure 8-4
Merced River Vegetation Communities



Graphics…00427.11 (3-2-2016)

Figure 8-5
Tuolumne River Vegetation Communities



Graphics...00427.11 (3-2-2016)

Figure 8-6
Stanislaus River Vegetation Communities

that maintained vegetation recruitment, survival, and mortality while water availability during summer drought limited riparian species distribution. This cycle of flooding and drought is especially significant to pioneer woody plant species, primarily willows (*Salix* spp.) and cottonwoods (*Populus* spp.), which rely on floods for bare seed beds, water, and nutrients, and which grow roots quickly to reach permanent water tables and a secure bank footing to resist subsequent floods (Stillwater Sciences 2003a).

Regeneration statistics are not available for riparian vegetation in California, but increased spring flows are believed to generally support the growth and dispersal of these species (CDFW 2014a). An analysis of historical data conducted in 2006 suggests that Fremont cottonwood (*Populus fremontii*) seed release coincided with peak runoff in almost all years, whereas Goodding's black willow (*Salix gooddingii*) and narrow-leaf willow (*Salix exigua*) seed dispersals typically took place during the spring flood recession after peak runoff (TID and MID 2011).

Riparian habitat has been significantly reduced by stream channelization, riprapping of stream banks, altered hydraulics, livestock grazing, and direct loss of habitat to agriculture and urban development (Riparian Habitat Joint Venture 2004; Moyle and Bennett 2008). As a result, wildlife corridors are narrow, riparian habitats are fragmented, stream temperatures have increased, channel variability has decreased, and little or no regeneration of riparian vegetation is occurring at many sites (Moyle and Bennett 2008; USBR 2011b).

Riparian forest is a broad vegetation category from which at least four major subtypes can be differentiated in the area of potential effects based on the dominant species: cottonwood riparian forest, willow riparian forest, mixed riparian forest, and valley oak riparian forest (Moise and Hendrickson 2002; Sawyer et al. 2009; USBR 2011b).

Cottonwood riparian forest is a multilayered riparian forest found on active, low floodplains. Common dominant trees in the overstory include Fremont cottonwood and Goodding's black willow (Sawyer et al. 2009). The midstory consists of shade-tolerant shrubs and trees, such as Oregon ash (*Fraxinus latifolia*) and California box elder (*Acer negundo*); California wild grape (*Vitis californica*) is also common. The understory typically is dominated by native grasses and forbs, such as stinging nettle (*Urtica dioica*) and sedges (*Carex* spp.)(Sawyer et al. 2009).

Willow riparian forest is dominated by black willow, but red willow (*Salix laevigata*) and arroyo willow (*S. lasiolepis*) are also common. Occasional scattered cottonwoods, ashes, or white alders (*Alnus rhombifolia*) may be present. Cover is generally dense. California buttonbush (*Cephalanthus occidentalis*) is often present (Sawyer et al. 2009).

Mixed riparian forest is a multilayered, winter-deciduous forest generally found on the intermediate terrace of the floodplain of the LSJR and the three eastside tributaries. Species dominance varies by environmental conditions, but typical dominants include Fremont cottonwood, box elder, Goodding's black willow, Oregon ash, and western sycamore (*Platanus racemosa*). Immediately along the water's edge, white alder may be found. The understory of mixed riparian forest is similar to that of cottonwood riparian forest (Sawyer et al. 2009).

Valley oak riparian forest varies from an open- to a closed-canopy habitat. This forest type is found on the higher portions of the floodplain. Besides valley oak (*Quercus lobata*), California sycamore, Oregon ash, and Fremont cottonwood are present. Common understory species are the California wild rose (*Rosa californica*), blackberry (*Rubus armeniacus* and *R. ursinus*), and California wild grape (Sawyer et al. 2009; USBR 2011b).

Riparian forests provide high-quality nesting habitat for raptors, such as red-tailed hawk (*Buteo jamaicenesis*), red-shouldered hawk (*B. lineatus*), Swainson's hawk (*B. swainsoni*), and white-tailed kite (*Elanus leucurus*). Riparian forest trees also provide nesting habitat for cavity-nesting species, such as downy woodpecker (*Picoides pubescens*), wood duck (*Aix sponsa*), northern flicker (*Colaptes auratus*), ash-throated flycatcher (*Myiarchus cinerascens*), oak titmouse (*Baeolophus inornatus*), tree swallow (*Tachycineta bicolor*), and white-breasted nuthatch (*Sitta carolinensis*). Riparian forests support large populations of insects that are prey for migratory and resident birds, including Pacific-slope flycatcher (*Empidonax difficilis*), western wood-pewee (*Contopus sordidulus*), olive-sided flycatcher (*C. cooperi*), warbling vireo (*Vireo gilvus*), orange-crowned warbler (*Vermivora celata*), yellow warbler (*Dendroica petechia*), Bullock's oriole (*Icterus bullockii*), and spotted towhee (*Pipilo maculatus*). Mammal species using riparian forests include coyote (*Canis latrans*), beaver (*Castor canadensis*), river otter (*Lontra canadensis*), raccoon (*Procyon lotor*), desert cottontail (*Sylvilagus audobonii*), and striped skunk (*Mephitis mephitis*) (USBR 2011b).

Scrub

Scrub habitat present in the area of potential effects includes willow scrub, riparian scrub, and elderberry savanna (Moise and Hendrickson 2002).

Willow scrub is a dense assemblage of shrubs found on riverbanks, in active channels subject to scouring flows, and especially on sand and gravel point bars immediately above the active river channels. Willows may survive three consecutive months of inundation (USBR 2011b). Dominant shrubs in willow scrub include sandbar willow (*Salix exigua*), arroyo willow, and red willow, although riparian trees such as Fremont cottonwood may also be present (Sawyer et al. 2009; USBR 2011b).

Riparian scrub consists of woody shrubs and herbaceous species. Depending on site conditions, some areas are dominated by mugwort (*Artemisia douglasiana*) and stinging nettle and various tall weedy herbs; others are dominated by blackberry or wild rose in dense thickets, sometimes with emergent willows. Such scrub associations may be maintained by periodic disturbance from fire or flood.

Elderberry savanna is typically found on floodplains (outside active channels), and is characterized by widely spaced blue elderberry shrubs (*Sambucus mexicana*) interspersed among nonnative grasses and forbs (Sawyer et al. 2009; USBR 2011b).

Bird species common to scrub habitat include various wrens (*Troglodytes* and *Thryomanes*), western wood-pewee, black phoebe (*Sayornis nigricans*), yellow-billed magpie (*Pica nuttalli*), bushtit (*Psaltriparus minimus*), buntings (*Passerina* spp.), tanagers (*Piranga* spp.), and American goldfinch (*Carduelis tristis*) (Sibley 2003; USBR 2011b). Animal species using scrub habitats are similar to those described for riparian forest habitats above, but may contain a wider variety of species, such as reptiles, because there is greater habitat diversity (USBR 2011b).

Emergent Wetlands

Emergent wetlands typically occur in the river bed adjacent to the low-flow river channels (Sawyer et al. 2009; USBR 2011b). Backwaters and sloughs support emergent marsh vegetation such as common tule (*Schoenoplectus acutus*), sedges (*Carex* spp.) and cattails (*Typha* spp.). Marsh species require shallow, periodic flooding of muddy benches and backwater areas. More ephemeral wetlands support an array of native and nonnative herbaceous species, including western goldenrod (*Euthamia occidentalis*), smartweed (*Polygonum* spp.), rushes (*Juncus* spp.), and dock (*Rumex* spp.).

Emergent wetlands support a wide variety of wildlife, including sparrows (*Melospiza* spp.), common yellowthroat (*Geothlypis trichas*), wrens (*Cistothorus*, *Troglodytes*, and *Thryomanes*), and red-winged blackbird (*Agelaius phoeniceus*) (Sibley 2003; USBR 2011b). Mammal species that use this habitat include beaver, voles (*Microtus* spp.), common muskrat (*Ondatra zibethicus*), and Norway rat (*Rattus norvegicus*). Emergent wetlands also sustain a variety of amphibians, especially Pacific chorus frog (*Pseudacris regilla*), American bullfrog (*Rana catesbeiana*) and garter snake (*Thamnophis elegans*) (CDFG 2007; USBR 2011b).

Grassland and Pasture

Grassland and pasture vegetation can exist adjacent to river channels on floodplains or where riparian habitat has been disturbed or converted. These locations are well drained and flood only occasionally. They are typically not connected hydrologically to the LSJR and the three eastside tributaries; therefore, grasslands and pastures are typically outside the area of potential effects affected by flow.

Various assemblages of nonnative annual and perennial grasses are predominating, as well as occasional nonnative and native forbs (Sawyer et al. 2009; USBR 2011b). Native grassland and bunchgrass populations may exist as well but are limited in distribution. Grasslands support a wide variety of bird species, including raptors such as northern harrier (*Circus cyaneus*) and white-tailed kite (*Elanus leucurus*), ring-necked pheasant (*Phasianus colchicus*), mourning dove (*Zenaida macroura*), burrowing owl (*Athene cunicularia*), horned lark (*Eremophila alpestris*), loggerhead shrike (*Lanius ludovicianus*), and sparrows (*Passerculus*, *Spizella*, and *Aimophila*) (Sibley 2003; USBR 2011b). Mammal species that use grasslands include California vole, deer mice (*Peromyscus* spp.), California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher (*Thomomys bottae*), desert cottontail (*Sylvilagus audobonii*), striped skunk (*Mephitis mephitis*), American badger (*Taxidea taxus*), fox, and coyote. Common amphibian and reptile species associated with grasslands in the San Joaquin Valley include western toad (*Bufo boreas*), alligator lizard (*Elgaria coerulea*), western fence lizard (*Sceloporus occidentalis*), western racer (*Coluber constrictor*), and gopher snake (*Pituophis catenifer*) (USBR 2011b). There is a very low potential for the LSJR alternatives to affect this type of habitat because it is outside of the river channels and not hydrologically connected.

Agriculture and Other Disturbed Areas

Agricultural lands consist primarily of orchards (citrus, stone fruits), vineyards, and annual crops (cotton, corn, lettuce, strawberries, rice, etc.), and occasionally cattle pasture. Although some land adjacent to the river channels has been developed for agriculture, these locations are typically well drained and flood only occasionally. Cropland can provide food and cover for wildlife species, but the value of the habitat varies greatly with crop type and agricultural practices. Typically, agricultural lands provide low-value habitat for wildlife (CDFG 2007).

Disturbed (ruderal) areas include roads, canals, and levees. As with agricultural habitats, low vegetation cover and low species diversity in disturbed habitats limit their value to wildlife. There is a low potential for the LSJR alternatives to directly affect agriculture and disturbed habitats because they are typically located in upland areas outside of the river channel.

Agricultural lands within the plan area, but outside of areas directly affected by flows or reservoir changes, are considered an area of potential indirect effect. Agricultural practices in this area vary due to numerous considerations including irrigation water availability. Changes could occur to agricultural lands in upland areas throughout the plan area as a result of changes to irrigation water availability. These changes could have potential indirect effects on sensitive species. Currently there are over 600,000 acres of agricultural lands[4] in the plan area (Table 11-2). This land is a mix of various crops and, as such, provides different habitat types and values to wildlife depending on the land cover. Habitat values within this area of potential indirect effects currently fluctuate in response to a number of variables including the type of crop grown on a particular property and different crop mixes on a property and in the area, all of which are influenced by the market and discrete farming decisions and practices. Habitat values are also influenced by common agricultural practices, such as harvesting, spraying, tilling, crop rotation, and fallowing. These activities typically vary within an agricultural season and between years.

Potentially Affected Vegetation

A spatial query of the CNDDB revealed multiple special-status plant species that could occur within potentially affected habitats (CDFG 2012). Most of these species (e.g., *Atriplex* spp.) are associated with habitats such as chenopod scrub, alkali sinks, and vernal pools that by their very nature are isolated from flowing waters. These habitats, although sometimes near active channels, are not hydrologically linked to the channels, and thus the special-status plants that require these habitats would not be affected by the LSJR alternatives. In addition, species associated with grasslands (e.g., big tar plant [*Blepharizonia plumose*]) would generally be located outside of river channels and thus have a very low potential to occur in river channels. Additionally, several species of special-status plants may potentially be found within the area of potential effects (zone of fluctuation) near the edges of the large reservoirs. Table 8-3a shows those vegetation species that could be located within the area of potential effects. Table 8-3b shows those vegetation species that could be located in the area of potential indirect effects.

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[4] Includes lands identified as Prime, Unique, Farmland of Statewide Importance, Farmland of Local Importance, and grazing lands.

Table 8-3a. Special-Status Plants with Potential to Occur or Known to Occur within the Area of Potential Effects – LSJR and the Three Eastside Tributaries

Scientific Name	Common Name	Status	Habitat Notes
Eryngium racemosum	Delta button-celery	CE, CNPS 1B.1	Associated with riparian scrub
Orcuttia inaequalis	San Joaquin Valley Orcutt grass	FT, CE	Grows on alluvial fans and stream terraces
Packera layneae	Layne's ragwort	FT, CNPS 1B	Associated with chaparral, cismontane woodland, and serpentine or gabbroic habitat
Clarkia biloba ssp. australis	Mariposa clarkia	CNPS 1B.2	Associated with chaparral and cismontane woodland habitat
Clarkia rostrata	Beaked clcarkia	CNPS 1B.3	Associated with cismontane woodland and valley/ foothill grassland
Lupinus spectabilis	Shaggyhair lupine	CNPS 1B.2	Associated with chaparral, cismontane woodland and serpentine habitat
Githopsis pulchella ssp. *serpentinicola*	Serpentine bluecup	CNPS 4.3	Associated with serpentine or Ione soils in oak woodlands
Eriophyllum confertiflorum var. *tanacetiflorum*	Golden yarrow	CNPS 4.3	Associated with oak woodland habitat
Helianthemum scoparium	Bisbee peak rush rose	CNPS 3.2	Associated with oak woodland habitat
Jepsonia heterondra	Foothill jepsonia	CNPS 4.3	Associated with chaparral habitat
Cryptantha mariposae	Mariposa cryptantha	CNPS 1B.3	Associated with chaparral and serpentine habitat
Verbena californica	California vervain	CNPS 1B FT, ST	Cismontane woodland, valley and foothill grassland, usually serpentine seeps and creeks
Allium tuolumnense	Red Hills onion	CNPS 1B	Associated with serpentine soils and found to occur around New Don Pedro Reservoir

Source: CDFG 2012.
CE = California listed as endangered
CNPS = California Native Plant Society rarity rank
FT = Federally listed as threatened

Table 8-3b. Special-Status Plant Species with Potential to Occur or Known to Occur within the Area of Potential Indirect Effects

Scientific Name	Common Name	Status	Presence in area of potential indirect effects
Brodiaea pallida	Chinese Camp brodiaea	FT, CE	Presumed surviving or in existence
Castilleja campestris var. succulenta	Succulent owl's-clover	FT, CE	Presumed surviving or in existence
Chloropyron palmatum	Palmate-bracted salty bird's-beak	FE, CE	Possibly removed
Eryngium racemosum	Delta button-celery	CE	Presumed surviving or in existence
Euphorbia hooveri	Hoover's spurge	FT	Presumed surviving or in existence
Lilaeopsis masonii	Mason's lilaeopsis	CR	Presumed surviving or in existence
Neostapfia colusana	Colusa grass	FT, CE	Presumed surviving or in existence
Orcuttia inaequalis	San Joaquin Valley Orcutt grass	FT, CE	Removed
Orcuttia pilosa	Hairy Orcutt grass	FE, CE	Removed
Packera layneae	Layne's ragwort	FT, CR	Presumed surviving or in existence
Pseudobahia bahiifolia	Hartweg's golden sunburst	FE, CE	Presumed surviving or in existence
Tuctoria greenei	Greene's tuctoria	FE, CR	Presumed surviving or in existence
Verbena californica	Red Hills vervain	FT, CT	Presumed surviving or in existence

Source: CDFW 2016.
CT = California Listed as Threatened
FT = Federally Listed as Threatened
CE = California Listed as Endangered
FE = Federally Listed as Endangered
CR = California Listed as Rare

Invasive Plants within Potentially Affected Habitats

Invasive plants are species that are not native to the area, generally persist without human assistance, and impact the environment to which they are introduced (Simberloff et al. 1997; USBR 2011b). There are a number of governmental agencies and nongovernmental organizations that have goals to limit or remove invasive species (see Section 8.3.1, *Federal [Regulatory Background]*, and Section 8.3.2, *State [Regulatory Background]*). The term *invasive plant* differs from the classification terms *nonnative*, *exotic*, or *introduced plant* because it describes those nonnative plant species that displace native species on a large enough scale to alter habitat functions and values.

The term *noxious weed* is used by government agencies for invasive nonnative plants that have been defined as pests by law or regulation (CDFG 2007).

Invasive riparian plants, especially giant reed (*Arundo donax*) and salt cedar (*Tamarix* spp.), displace native riparian vegetation and provide lower-quality habitat for native wildlife (CDFG 2007). Invasive plants may not sustain the rich invertebrate communities or provide forage for terrestrial wildlife as effectively as do native riparian plants (CDFG 2007; USBR 2010a). Invasive riparian plants also colonize channel and floodplain surfaces that can alter hydrologic processes and interfere with flood control (Moyle and Bennett 2008; USBR 2010a, 2011b). Removal or control of invasive riparian plants constitutes a substantial investment of capital resources (CDFG 2007; USBR 2010a).

Some of the most prevalent invasive plants in the area of potential effects are: red sesbania (*Sesbania punicea*); salt cedar; giant reed; purple loosestrife (*Lythrum salicaria*); Chinese tallow (*Sapium sebiferum*); tree-of-heaven (*Ailanthus altissima*); Eucalyptus (*Eucalyptus* spp.); pampas grass (*Cortaderia selloana*); fig (*Ficus* spp.); Himalayan blackberry (*Rubus armeniacus*); white mulberry (*Morus alba*); castor bean (*Ricinus communis*); Lombardy poplar (*Populus nigra*); and tree tobacco (*Nicotiana glauca*) (CDFG 2007; USBR 2010a, 2011). Also prevalent in the area of potential effects are emergent and submergent invasive aquatic plants, such as parrot feather, milfoils (*Myriophyllum* spp.), and water primrose (*Ludwigia* spp.); herbaceous weeds, such as thistles (*Centaurea* spp., *Cirsium* spp., *Carduus* spp., etc.); European annual grasses (*Avena* spp., *Cynodon* spp., *Echinochloa* spp., etc.); and numerous forbs that compete with native riparian species for shoreline and low floodplain establishment and growth sites.

Reduction of habitat quality in riparian ecosystems has contributed to the decline of native tree species and opened a niche for invasion by salt cedar in the western United States (Shafroth et al. 1995; Carter and Nippert 2012). In many riparian areas, salt cedar has replaced stands dominated by native Fremont cottonwood, decreasing habitat quality for native species and altering fluvial processes (Shafroth et al. 1995). Smaller peak flows in the river channels as a result of managed flow releases have also reduced leaching of salts from floodplain soils, perhaps favoring the salt-tolerant plants such as salt cedar (Shafroth et al. 1995).

Invasive Plants within Area of Potential Indirect Effects

Invasive plant species occurring within the area of potential indirect effects (all upland agricultural lands outside of river channels and reservoirs) include common herbaceous weeds such as thistles (*Onopordum* spp, *Cirsium spp*, *Carduus* spp, etc.) and knapweed (*Centaurea* spp.). These examples of invasive plant species are typical of those types of species found in and around agricultural lands in the area of potential indirect effects. The California Invasive Plant Council (Cal-IPC) has identified 9 invasive plant species within the South Central Valley region (San Joaquin, Stanislaus, and Merced Counties) for eradication, with an additional 31 species identified for active management (Cal-IPC 2012b). Containment and eradication of invasive plant species on agricultural lands often requires the use of herbicides or mechanical removal

Potentially Affected Wildlife

Historically, the San Joaquin Valley was composed of wetlands, grasslands, broad riparian corridors, scrub, and bunchgrass habitats. The valley supported a diverse assemblage of wildlife species, such as bison, elk, and grizzly bears. However, agricultural, urban, and commercial development have reduced, fragmented, and heavily modified natural habitat on the valley floor. Although few large mammals remain in the San Joaquin Valley, the remnant habitat continues to support a diverse group of vertebrate and invertebrate species (CDFG 2003). Table 8-4a lists the special-status animal species identified by a spatial query of the CNDDB within the area of potential effects (CDFG 2012). Table 8-4b shows those wildlife species that could be located in the area of potential indirect effects, many of which occur adjacent to the river channels.

Table 8-4a. Special-Status Animal Species with Potential to Occur or Known to Occur within the Area of Potential Effects– LSJR and the Three Eastside Tributaries

Scientific Name	Common Name	Status	Habitat Notes
Actinemys marmorata	western pond turtle	CSC	Slack- or slow-water aquatic habitat. Tulloch Reservoir implements a special-species plan. Present around reservoir shoreline at New Don Pedro Reservoir and Lake McClure.
Agelaius tricolor	tricolored blackbird	CSC, MB	Marsh and scrub habitats used for nesting.
Antrozous pallidus	pallid bat	CSC	Grassland, scrub, and forest.
Ardea herodias	great blue heron	CSC, MB	Saltwater and freshwater marshes, sloughs, riverbanks, and reservoirs (lakes). Forages in grasslands and agricultural fields.
Branta hutchinsii leucopareia	Aleutian Canada goose	Delisted, MB	Forages on pastures, harvested fields, and wetlands; roosts on flooded fields and ponds at night.
Buteo swainsoni	Swainson's hawk	CT, MB	Nests in riparian areas.
Calicina breva	Stanislaus harvestman	CSC	Various habitats.
Coccyzus americanus occidentalis	western yellow-billed cuckoo	CE, MB	Uses riparian areas for cover, foraging, and breeding.
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	FT	Dependent on the elderberry shrub, a riparian species.
Egretta thula	snowy egret	CSC, MB	Marshes, swamps, shorelines, mudflats, and ponds.
Haliaeetus leucocephalus	bald eagle	CE, MB	Requires large, old-growth trees or snags in mixed stands near large bodies of water or free-flowing rivers with abundant fish.
Lasiurus blossevillii	western red bat	CSC	Associated with riparian habitat.
Myotis yumanensis	Yuma myotis	CSC	Optimal habitats are open forests and woodlands with sources of water over which to feed.
Neotoma fuscipes riparia	San Joaquin Valley woodrat	FE	Restricted primarily to riparian areas where trees and brush are found.
Pandion haliaetus	Osprey	CSC, MB	Wide range of habitats near water, primarily reservoirs (lakes), rivers, and coastal waters with adequate supplies of fish.
Perognathus inornatus	San Joaquin pocket mouse	CSC	Dependent on riparian forests with dense understory. Present in Caswell Memorial State Park on the Stanislaus River.

Scientific Name	Common Name	Status	Habitat Notes
Rana aurora draytonii	California red-legged frog	FT, CSC	Permanent and semi-permanent aquatic habitats such as creeks and coldwater ponds with emergent and submergent vegetation and riparian species along the edges.
Sylvilagus bachmani riparius	riparian brush rabbit	FE, CE	Dependent on riparian forests with dense understory that include floodplains with upland area for retreat from high waters. Present in Caswell Memorial State Park on the Stanislaus River.

Source: CDFG 2012.

FE	= Federally listed as endangered
FT	= Federally listed as threatened
MB	= Migratory Bird Act
CE	= California listed as endangered
CT	= California listed as threatened
CSC	= California species of special concern
CFP	= California fully protected species

Table 8-4b. Special-Status Animal Species with Potential to Occur or Known to Occur within the Area of Potential Indirect Effects

Scientific Name	Common Name	Status	Presence in area of potential indirect effects
Ambystoma californiense	California tiger salamander	FT, CT	Presumed surviving or in existence
Branchinecta conservatio	Conservancy fairy shrimp	FE	Presumed surviving or in existence
Branchinecta longiantenna	Longhorn fairy shrimp	FE	Presumed surviving or in existence
Branchinecta lynchi	Vernal pool fairy shrimp	FT	Presumed surviving or in existence
Branta hutchinsii leucopareia	Cackling goose/Aleutian Canada goose	Delisted	Presumed surviving or in existence
Buteo swainsoni	Swainson's hawk	CT	Presumed surviving or in existence
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	FT, CE	Possibly removed
Corynorhinus townsendii	Townsend's big-eared bat	CA candidate Threatened	Presumed surviving or in existence
Desmocerus californicus dimorphus	Valley elderberry longhorn beetle	FT	Presumed surviving or in existence
Gambelia sila	Blunt nosed leopard lizard	FT	Presumed surviving or in existence
Haliaeetus leucocephalus	Bald eagle	Federal Delisted, CE	Presumed surviving or in existence
Hydromantes brunus	Limestone salamander	CT	Presumed surviving and in existence
Lepidurus packardi	Vernal pool tadpole shrimp	FE	Presumed surviving or in existence

Scientific Name	Common Name	Status	Presence in area of potential indirect effects
Masticophis lateralis euryxanthus	Alameda whipsnake	FT, CT	Presumed surviving or in existence
Neotoma fuscipes riparia	Riparian woodrat/San Joaquin Valley woodrat	FE	Presumed surviving or in existence
Rana draytonii	California red-legged frog	FT	Presumed surviving and in existence
Sylvilagus bachmani riparius	Riparian brush rabbit	FE, CE	Presumed surviving or in existence
Thamnophis gigas	Giant gartersnake	FT, CT	Presumed surviving or in existence
Vireo bellii pusillus	Least Bell's vireo	FE, CE	Possibly removed
Vulpes macrotis mutica	San Joaquin kit fox	FE, CT	Presumed surviving or in existence

Source: CDFW 2016.
CT = California Listed as Threatened
FT = Federally Listed as Threatened
CE = California Listed as Endangered
FE = Federally Listed as Endangered
CR = California Listed as Rare

Nonnative Wildlife

The introduction of nonnative wildlife species can be detrimental to native species assemblages. The distribution and abundance of nonnative wildlife species in the area of potential effects are not fully documented, but species include American bullfrog (*Lithobates catesbeiana*), red swamp crayfish (*Procambarus clarkii*), red-eared slider (*Trachemys scripta*), European snails (e.g., *Helix* spp.), and Chinese mitten crab (*Eriocheir sinensis*) (USBR 2010a).

8.2.2 Reservoirs

This section describes the area of potential effects at the three rim dams (New Melones, New Don Pedro, and New Exchequer) and their respective reservoirs (New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure). As a result of the LSJR alternatives, water surface elevations are expected to change, but generally this change would be within the current zone of fluctuation at the three rim dams and reservoirs (Tables 8-7a, 8-7b, and 8-7c and Section 8.4.2, *Methods and Approach*). Therefore, the area of potential effects at the three rim dams and reservoirs is limited to the area along their banks that would experience this change in water level.

Water surface elevations in smaller downstream reservoirs on the three eastside tributaries are maintained through water releases from the rim dams upstream. These downstream reservoirs are used to regulate the flow released by the upstream rim dams. Although more flow might go through these smaller downstream reservoirs as a result of the LSJR alternatives, the reservoirs would simply release the flow downstream, so surface elevations of the smaller downstream reservoirs are not expected to change under the LSJR alternatives.

Potentially Affected Habitats

While there are a multitude of different habitat types within the vicinity of the reservoirs, annual grasses and disturbed/barren habitats make up the majority of the habitat types found within the area of potential effects around the reservoirs. Small segments of riparian and wetland habitat exist around the reservoirs at some locations where tributaries meet the reservoir within the zone of water level fluctuation. Information from the Don Pedro Hydroelectric Project (TID and MID 2014), the Merced River Hydroelectric Project (Merced ID 2010; Merced ID 2011a), and the New Melones Lake Resource Management Plan (USBR 2010b) documents and technical studies (herein after referred to collectively as the reservoir studies) were reviewed to determine whether the presence of special-status habitat types existed in the area of potential effects. There were no special-status habitat types located within the vicinity of New Melones and New Don Pedro reservoirs due to the reservoirs' steep-sided banks and regular water level fluctuations. Investigations done as part of the Merced River relicensing proceeding revealed the presence of limestone salamander, a California fully protected species that inhabits steep-sided talus slopes and rocky habitat around Lake McClure (Merced ID 2011b). Additionally, BLM has established the Bagby Serpentine Area of Critical Environmental Concern in the vicinity of the upstream end of Lake McClure near Bagby. The Bagby Serpentine Area of Critical Environmental Concern also includes land bordering the Lake McClure and the Red Hills Area of Critical Environmental Concern, which is located near New Don Pedro Reservoir and may overlap portions of the area of potential effects at that reservoir.

Annual Grassland

Annual grassland is typically found at the higher elevations of the area of potential effects of the reservoirs where water inundation occurs least frequently. Studies of the vegetation around the reservoirs found annual grasses were present along the reservoir shores just below the high water line creating a "bathtub ring" effect. Many of the vegetative species within this classification are nonnative and invasive. Dominant species include the following: ripgut brome (*Bromus diandrus*), Italian ryegrass (*Lolium multiflorum*), soft chess (*Bromus hordeaceus*), wild oats (*Avena barbata*), silver hairgrass (*Aira carophyllea*), and the highly invasive Bermudagrass (*Cynodon dactylon*) which was found to be very common along the reservoirs.

Terrestrial wildlife species associated with this vegetation type closely follow that of the grassland and pasture vegetation classification as discussed in Section 8.2.1, *LSJR and the Three Eastside Tributaries*.

Disturbed/Barren

The reservoir studies found the areas below the normal maximum surface elevations, which are periodically exposed, were sparsely vegetated and/or bare. As such, the disturbed/barren vegetation classification is similar to the disturbed/barren habitat classification discussed previously in Section 8.2.1, *LSJR and the Three Eastside Tributaries*. Typically, this habitat classification includes areas such as roads, canals, levees, and the area of potential effects below the annual grassland vegetation community. Areas that are not found barren within this classification are sparsely inhabited by the annual grassland species discussed above.

While several terrestrial/semi-aquatic wildlife species (i.e., Western pond turtle) maybe found within the disturbed/barren habitat classification, these areas generally have relatively low habitat value due to steep slopes and reduced vegetation, as they afford few opportunities for native wildlife populations, and support little wildlife biodiversity overall (TID and MID 2014). There is a special-status amphibian species, Limestone salamander, which is present around Lake McClure. It is found mainly on the surface in mixed chaparral habitats during moist periods. During the remainder of the year, they can be found below the surface in habitat that includes limestone caverns, deep talus formations, and massive rock fissures (Merced ID 2011b).

Wetland and Riparian

Studies on riparian and wetland habitat around Lake McClure identified the presence of small, ephemeral wetlands at the mouth of drainages where flows from the drainages and the reservoir water level inundate the finger-like drainage beds (Merced ID 2011a). As snowmelt raises the water level of Lake McClure, these wetlands become fully submerged until reservoir levels drop again during fall months. Dominant species in these wetland areas include broadleaf cattails, various species of rush, leather root (*Hoita macrostachya* [*Psoralea macrostacha*]), and California loosestrife (*Lythrum californicum)*. Where soil conditions are saturated but not inundated, Italian thistle (*Carduus pycnocephalus)* is often the dominant species, providing full ground cover. Where soils are slightly less wet, along shallow drainages, seeps, or directly adjacent to inundated temporary wetlands, Italian ryegrass (*Lolium multiflorum)* is dominant; it often occurs in conjunction with Italian thistle. At most drainages, the riparian vegetation community becomes well-developed and vigorous at the high water line, remaining healthy until the natural landscape no longer supports hydric conditions necessary for riparian vegetation. Button willow also occurs intermittently below the high-water line of Lake McClure.

Areas at the mouth of the drainages that enter Lake McClure are inundated for longer durations than other locations around the reservoir and frequently support wetland vegetative species. Riparian vegetation tends to increase in abundance farther up the drainage, where inundation occurs for a shorter duration during the year, with full expression of riparian vegetation occurring near the high water line of the lake, where inundation occurs less frequently and for shorter durations. Various special-status plant species were found around New Don Pedro Reservoir and Lake McClure as a result of studies that were completed for the FERC relicensing on the Tuolumne and Merced Rivers (Merced ID 2011a; TID and MID 2013b).

BLM Areas of Critical Environmental Concern

The Bureau of Land Management (BLM) is a federal land management agency that is responsible for the management of some of the public lands located around the reservoirs. To better protect certain rare or otherwise valuable habitat, BLM establishes Areas of Critical Environmental Concern (ACECs), which are areas of public land where special management attention is required to protect relevant and important natural or cultural resource values. The current Sierra Resource Management Record of Decision (Sierra ROD), completed in 2008, describes the special resource values present in the two ACECs located near the reservoirs, the Red Hills ACEC in the vicinity of New Don Pedro Reservoir and the Bagby Serpentine ACEC located near the upper portions of Lake McClure. These two ACECs, described in more detail below, were designated due to the presence of rare plant communities that are associated with unique soil characteristics at these two locations.

The Red Hills ACEC includes: Delpiedra soils derived from dunite and serpentine, two federally listed species (*Verbena californica* and *Packera layneae*), four BLM sensitive species (*Allium tuolumnense, Chlorogalum grandiflorum, Lomatium congdonii,* and *Senecio clevelandii heterophyllus*), and the serpentine buckbrush chaparral plant community.

The Bagby Serpentine ACEC, which overlaps a portion of the area of potential effects around Lake McClure, was designated to protect a rare plant community characterized by the presence of serpentine soils. As described in the Sierra ROD, relevant and important values at this location are the Henneke soil series soils developed on a serpentine substrate supporting at least two BLM sensitive serpentine endemic species (*Lupinus spectabilis* and *Cryptantha mariposae*), other serpentine endemics, and the serpentine buckbrush chaparral community.

Both of these ACECs contain portions of the designated area that border the shorelines at New Don Pedro Reservoir and Lake McClure. Special-status plants associated with these ACECs were found to exist in the area of potential effects at these two reservoirs.

Potentially Affected Vegetation

The vegetative species found within the area of potential effects are accustomed and acclimatized to large interannual and annual variations in the reservoirs' water surface elevations that occur as part of reservoir operations. Nonnative plants dominate much of the potential area of effects along the reservoirs' banks and limit the potential for native plant species to grow, however observations have been made during studies around New Don Pedro Reservoir and Lake McClure of several special-status plant species around the edge of the reservoir. Since the range in water level fluctuation is not expected to substantially change compared to baseline conditions, the potentially affected vegetation around reservoirs is confined to the area immediately around the reservoir.

Invasive Plants Within Potentially Affected Habitats

As discussed in Section 8.2.1, *LSJR and the Three Eastside Tributaries*, a number of invasive plants are present within the potentially affected habitat. The reservoir studies documented the dominance of European annual grasses and forbs in the annual grassland habitat found along the reservoirs' banks.

Potentially Affected Wildlife

Those special-status wildlife species with the potential to occur within the area of potential effects around the reservoirs are the same as those listed in Table 8-4. However, the reservoir studies did note the lack of abundance of special-status species within the area of potential effects as a result of the limited amount of appropriate habitat and the overall number of invasive species. An exception was the limestone salamander (*Hydromantus brunus),* which has a designation of California listed as threatened, California fully protected species. This species has a range restricted Lake McClure and its tributaries on steep north and east-facing slopes in chaparral habitats during moist periods and in limestone caverns, deep talus, and rock fissures during the remainder of the year. This species spends much of the time below the surface during the dry season and is generally only found above ground during the rainy season when it emerges. Western pond turtles (*Actinemys marmorata*) were also observed around the shore of New Don Pedro Reservoir. These species are accustomed to the frequent changes in water level elevations.

Nonnative Wildlife

The nonnative wildlife species found within the areas of effects along the reservoirs' banks are the same as those described in Section 8.2.1, *LSJR and the Three Eastside Tributaries*. The reservoir studies identify the abundance of American bullfrogs and red swamp crayfish.

8.2.3 Extended Plan Area

Unlike the plan area, where the elevation primarily decreases from the rim dams and becomes flat in the valley, the extended plan area dramatically increases in elevation to the top of the three eastside tributary watersheds. This elevation change influences the types of habitat and vegetation that are found in the area. The vegetation zonation reflects the increase in elevation with associated declines in temperature, increased precipitation, and winter snow at higher elevations. At the uppermost reaches of the Stanislaus, Tuolumne, and Merced Rivers, alpine vegetation or bare bedrock is dominant. Below the alpine zone are subalpine forest, lodgepole-red fir forest, yellow pine forest, foothill woodlands, and chaparral (Schoenherr 1992:92).

There are several special-status animal species in the extended plan area located within the area of potential effects of the rivers and reservoirs. These include valley elderberry longhorn beetle, willow flycatcher (*Empidonax trailii,* CE), and the harlequin duck (*Histrionicus*, CSC). There are two special-status amphibians in the upper watersheds of the extended plan area. These are the Sierra Nevada yellow-legged frog (*Rana sierrae,* FT, CT) and the Yosemite toad (*Bufos canorus,* FT, CSC) (CDFG 2012).

There are no federal or state endangered or threatened plant species associated with reservoirs in the extended plan area. There are several rare plant species associated with reservoir wetland habitats. These include yellow-lipped pansy monkeyflower *(Mimulus pulchellus),* three-bracted onion *(Allium tribracteatum)* and a moonwort *(Botrychium crenulatum)* (CDFG 2012).

Within the Stanislaus National Forest the following acreages have been identified as wildlife habitat: big game (804,700); small game (112,800); bald eagle (3,000); peregrine falcon (15,000); Sierra red fox (100,000); fisher (220,000); pine marten (245,000); spotted owl (120,000); goshawk (104,000); great grey owl (10,000) (USFS 2016).

8.2.4 Southern Delta

The southern Delta once consisted of tidal marshlands, numerous islands, and hundreds of miles of waterways. Upland islands, meandering natural levees, and terraces supported woody riparian vegetation, grassland, and shrubs. Marshlands were drained and reclaimed for irrigated agriculture (CDFG 2007). Today, agricultural land dominates the southern Delta. Levees typically have waterside slopes that are covered with riprap and actively maintained with regular herbicide application to control vegetation. Interior areas of most islands are actively farmed and contain little or no natural vegetation. Consequently, most remaining undisturbed plant communities and most special-status species occur on in-channel islands with no levees (CDFG 2007).

The vegetation, wildlife, and special-status species of the area of potential effects for the SDWQ alternatives are similar to that of the area of potential effects for the LSJR alternatives. The following is a discussion of vegetation, wildlife, and special-status species that are specific to the area of potential effects for the SDWQ alternatives.

Potentially Affected Habitats

The southern Delta contains numerous and varied vegetation communities and land cover types. The majority of the area of potential effects is nonflooded agriculture, followed by grassland, orchards, and vineyards (particularly in the southwestern portion of the southern Delta) (CDFG 2005). A spatial query of the CNDDB revealed the following special-status habitats reported within the area of potential effects: great valley cottonwood riparian forest, great valley mixed riparian forest, great valley oak riparian forest, and northern claypan vernal pool (CDFG 2012). With the exception of northern claypan vernal pools, these habitats are discussed above. Vernal pool habitats are not discussed further because they are isolated from the waterways that could be modified by the plan amendments. There is no critical habitat designated for terrestrial species in the southern Delta. Near the waterways and within the area of potential effects, the dominant habitat types are aquatic. These habitat types are discussed below.

Tidal Freshwater Emergent Wetland

Tidal freshwater emergent wetland habitat is typically a transitional community between tidal perennial aquatic, riparian, and various terrestrial upland communities. It often occurs at the shallow, slow-moving, or stagnant edges of fresh waterways in the intertidal zone and is subject to frequent, long duration flooding. Tidal freshwater emergent wetland habitat is distributed in narrow, fragmented bands along island levees, in-channel islands, shorelines, sloughs, and shoals. In the southern Delta, bulrushes (*Scirpus* spp.), tules, and common reed (*Phragmites australis*) are often the dominant plant species within this community type.

Tidal Mudflat

Tidal mudflat habitat typically occurs as sparsely vegetated sediment deposits in the intertidal zone between the mean higher high tide and the mean lower low water level. It is typically associated with the tidal freshwater wetland community at its upper edge and the tidal perennial aquatic community at its lower edge. The tidal mudflat natural community is ephemeral and owes its physical existence to sediment erosion and deposition processes that vary throughout the Delta. At least two special-status plant species, Mason's lilaeopsis (*Lilaeopsis masonii*) and Delta mudwort (*Limosella subulata*), are found in this community type (Fiedler et al. 2007).

Nontidal Perennial Aquatic

Nontidal perennial aquatic habitat can be found in association with any terrestrial habitat and often transitions into nontidal freshwater perennial emergent wetland and riparian habitats. Specific plant species vary with water depth and distance from shore and include submerged aquatic species (e.g., pondweed [*Potamogeton* spp.] and Brazilian waterweed [*Egeria densa*]) and floating aquatic vegetation (e.g., duckweed [*Lemna* spp.]) and water hyacinth [*Eichhornia crassipes*]). This community is often dominated by nonnative species and may alter the environment by increasing rates of sediment and organic matter accumulation (BDCP 2010).

Nontidal Freshwater Perennial Emergent Wetland

These perennially-saturated wetlands are composed of emergent vegetation that cannot tolerate perpetual exposure to saline or brackish conditions. Nontidal freshwater perennial emergent wetland habitat occurs adjacent to nontidal perennial aquatic and riparian natural communities, typically occurring as associated pockets of habitat (BDCP 2010).

Potentially Affected Vegetation

A spatial query of the CNDDB revealed special-status plant species with potential to occur within the area of potential effects (Table 8-5) (CDFG 2012). The species associated with riparian forests are discussed above for the LSJR alternatives. Vegetation unique to the southern Delta area of potential effects is discussed below.

Table 8-5. Special-Status Plants with Potential to Occur or Known to Occur within the Area of Potential Effects – Southern Delta

Scientific Name	Common Name	Status	Habitat Notes
Cirsium crassicaule	slough thistle	CNPS 1B.1	Chenopod scrub, marshes and swamps, sloughs, and riparian scrub.
Eryngium racemosum	Delta button-celery	CE	Riparian scrub.
Hibiscus lasiocarpos	woolly rose-mallow	CNPS 2.2	Freshwater marsh.
Lathyrus jepsonii var. jepsonii	Delta tule pea	CNPS 1B.2	Freshwater and brackish marshes.
Lilaeopsis masonii	Mason's lilaeopsis	CNPS 1B.1	Intertidal brackish and freshwater marshes along streambanks.
Limosella subulata	Delta mudwort	CNPS 2.1	Marshes and swamps, muddy or sandy intertidal flats.
Symphyotrichum lentum	Suisun Marsh aster	CNPS 1B.2	Freshwater and brackish marshes.
Trichocoronis wrightii var. *wrightii*	Wright's trichocoronis	CNPS 2.1	Meadows, marshes and swamps, riparian forest, and alkaline vernal pools.

Source: CDFG 2012.
CE = California listed as endangered
CNPS = California Native Plant Society rarity rank

Invasive Plants within Potentially Affected Habitats

Some of the most prevalent invasive plants in the area of potential effects are thistles, European annual grasses, salt cedar, giant reed, Chinese tallow, tree-of-heaven, Eucalyptus, pampas grass, edible fig, Himalayan blackberry, white mulberry, castor bean, Lombardy poplar, tree tobacco, and emergent and submergent invasive aquatic plants (CDFG 2007; USBR 2010a, 2011). Invasive plants displace native vegetation and provide lower-quality habitat for native wildlife (CDFG 2007). Invasive plant stands may not sustain rich invertebrate communities or provide forage for terrestrial wildlife as effectively as do native communities (CDFG 2007; USBR 2010a). Invasive riparian plants also colonize channel and floodplain surfaces that can alter hydrologic processes and interfere with flood control (Moyle and Bennett 2008; USBR 2010a, 2011).

Potentially Affected Wildlife

More than 200 species of wildlife utilize the terrestrial habitats of the Delta (CDFG 2003). Wildlife habitats in the area of potential effects include agricultural land, riparian forest, riparian scrub, emergent freshwater marsh, mudflats, grassland, and rangeland. The Delta is particularly important to waterfowl migrating via the Pacific Flyway. The principal attraction for waterfowl is winter-flooded fields, mainly cereal crops, which provide food and extensive seasonal wetlands. The Delta and other Central Valley wetlands provide winter habitat for 60 percent of the 5 million waterfowl on the Pacific Flyway and 90 percent of all waterfowl that winter in California (CDFG 2003). Approximately 27 species of waterfowl are found in the Delta and LSJR (CDFG 2003). Raptor species, including bald eagle, prairie falcon (*Falco mexicanus*), and great-horned owl (*Bubo virginianus)*, hunt in the wetlands, grasslands, and riparian habitats. Many passerines, including species of flycatchers, swallows, warblers, blackbirds, and sparrows, nest, forage, or overwinter in the variety of habitats associated with the Delta. Upland game birds include dove, pheasant, chukar, and quail. Shorebirds include gulls, terns, plovers, sandpipers, herons, and egrets (CDFG 2003).

Small mammals find suitable habitat in the Delta and upland areas. Vegetated levees, remnants of riparian forest, and undeveloped islands still sustain approximately 40 species of mammals (CDFG 2003). Species include muskrat, mink, river otter, beaver, raccoon, gray fox, California ground squirrel, antelope ground squirrel, and skunk.

Herpetofauna of the area include garter, gopher, night, and king snakes; western pond turtle; leopard, fence, alligator, and side-blotched lizards; skinks and whiptails; red-legged frogs, yellow-legged frogs, tree frogs, and bullfrogs; and tiger and slender salamanders. The southern Delta is also home to thousands of insect and other invertebrate species, such as over a hundred beetle species and many rare native bees (e.g., Adrenidae) (Powell and Hogue 1979).

The loss or alteration of most of the natural habitat in the Delta has resulted in the decline of the Delta's sensitive and rare terrestrial species. A spatial query of the CNDDB revealed multiple special-status animal species within the area of potential effects (Table 8-6) (CDFG 2012). Many of the species are avian and dependent on the availability of riparian habitat.

Nonnative Wildlife

The introduction of nonnative wildlife species can be detrimental to native species assemblages. The distribution and abundance of nonnative wildlife species in the area of potential effects are not fully documented in the southern Delta, but among the species that occur are red fox (*Vulpes vulpes*), common starling (*Sturnus vulgaris*), American bullfrog, brown-headed cowbird (*Molothrus ater*), and feral pig and cat (CDFG 2003).

Table 8-6. Special-Status Animals with Potential to Occur or Known to Occur within the Area of Potential Effects – Southern Delta

Scientific Name	Common Name	Status	Habitat Notes
Actinemys marmorata	western pond turtle	CSC	Uses slack- or slow-water aquatic habitat.
Agelaius tricolor	tricolored blackbird	CSC, MB	Uses marsh and scrub habitats for nesting.
Ambystoma californiense	California tiger salamander	FT, CE	Inhabits grassland and oak woodland habitats below 1,500 feet which have scattered ponds, intermittent streams, or vernal pools.
Anthicus sacramento	Sacramento anthicid beetle	CSC	Inhabits sandy substrate among willows in riparian habitats.
Athene cunicularia	burrowing owl	CSC, MB	Uses open, dry grasslands, deserts, prairies, farmland, and scrublands with abundant active and abandoned mammal burrows inside levees.
Buteo swainsoni	Swainson's hawk	CT, MB	Nests in a variety of tree species often in or near riparian habitat. Forages in grasslands and agricultural fields.
Circus cyaneus	northern harrier	CSC, MB	Nests and forages in grasslands and agricultural fields, often at the edge of marshes.
Coccyzus americanus occidentalis	western yellow-billed cuckoo	CE, MB	Uses riparian areas for cover, foraging, and breeding.
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	FT	Dependent on the elderberry shrub, a riparian species.
Falco columbarius	Merlin	MB	Prefers open habitats such as grasslands, marshlands, deserts, coasts, sand dunes and steppes.
Neotoma fuscipes riparia	San Joaquin Valley woodrat	FE	Restricted primarily to riparian areas where trees and brush are found.
Perognathus inornatus	San Joaquin pocket mouse	CSC	Dependent on riparian forests with dense understory.
Sylvilagus bachmani riparius	riparian brush rabbit	FE, CE	Dependent on riparian forests with dense understory that include floodplains with upland area for retreat from high waters.
Taxidea taxus	American badger	CSC	Uses grasslands and levees.
Xanthocephalus	yellow-headed blackbird	CSC, MB	Uses wetlands.

Source: CDFG 2012.

FE = Federally listed as endangered
FT = Federally listed as threatened
MB = Migratory Bird Act
CE = California listed as endangered
CT = California listed as threatened
CSC = California species of special concern

8.3 Regulatory Background

8.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to terrestrial biological resources are described below.

Clean Water Act

The CWA generally applies to all navigable waters of the United States and is discussed in Chapter 5, *Surface Hydrology and Water Quality*.

Central Valley Project Improvement Act

The Central Valley Project Improvement Act (CVPIA) was enacted in 1992 to balance the needs of fish and wildlife resources with other uses of CVP water. The purposes of the CVPIA are as follows.

- Protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River Basins of California.
- Address impacts of the CVP on fish, wildlife, and associated habitats.
- Improve the operational flexibility of the CVP.
- Increase water-related benefits provided by CVP to the State of California through expanded use of voluntary water transfers and improved water conservation.
- Contribute to California's interim and long-term efforts to protect the Bay-Delta Estuary.
- Achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agricultural, municipal and industrial, and power contractors.

The CVPIA added mitigation, protection, and restoration of fish and wildlife to the purposes of the CVP, dedicated 800,000 AF of CVP yield for the primary purpose of implementing fish, wildlife, and habitat restoration, and created a Central Valley Project Restoration Fund to carry out CVPIA programs, projects, plans, and habitat restoration, improvement, and acquisition provisions.

Section 3406(d) of the act requires the Secretary of the Interior to

> provide, either directly or through contractual agreements with other appropriate parties, firm water supplies of suitable quality to maintain and improve wetland habitat areas on units of the National Wildlife Refuge System in the Central Valley; on Gray Lodge, Los Baños, Volta, North Grasslands, and Mendota state wildlife management areas; and on the Grasslands Resources Conservation District in the Central Valley of California.

The volumes of water necessary are divided into Level 2 water supply needs that are to be made immediately available and Level 4 water supply needs, which are to be made available no later than 10 years after CVPIA's enactment.

CVPIA and Section 210(b) of the Reclamation Reform Act of 1982 also require the preparation and submittal of Water Management Plans from certain entities that enter into repayment contracts or water service contracts with the U.S. Bureau of Reclamation (USBR) (USBR 2015b). These plans document the use and amount of water under different federal levels. The following national wildlife refuges and other wildlife areas have submitted water management plans because of their use of contracted water: North Grasslands Wildlife Area; SJR National Wildlife Refuge; Merced National Wildlife Refuge; and San Luis National Wildlife Refuge.

Federal Endangered Species Act of 1973

The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. (16 U.S.C., § 1531 et seq.) ESA is administered by USFWS and NMFS. In general, NMFS is responsible for protecting ESA-listed threatened or endangered marine species and anadromous fishes, while other listed species (e.g., freshwater and terrestrial species) are under USFWS jurisdiction. An *endangered species* is defined as "… any species which is in danger of extinction throughout all or a significant portion of its range." (16 U.S.C., § 1532, subd. (6).) A *threatened species* is defined as "… any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." (16 U.S.C., § 1532, subd. (20).) ESA Section 9 makes it illegal to *take* (i.e., harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in such conduct) any endangered fish or wildlife species. (16 U.S.C., §§ 1538; 1532, subd. (19).) For threatened fish and wildlife species, ESA Section 4(d) allows for the adoption of protective regulations, including provisions extending the Section 9 take prohibition to that species. (16 U.S.C., § 1538, subd. (d).)

ESA also requires the designation of critical habitat for listed species. *Critical habitat* is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to a species' conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (NMFS 2011; NMFS 2009a; ICF International 2012).

If a federal agency believes that its action will jeopardize a listed species or destroy or adversely modify critical habitat, the agency must request formal consultation with USFWS or NMFS, as appropriate, under Section 7 of ESA. (16 U.S.C., § 1536.) USFWS or NMFS then issues a biological opinion (BO) as to whether the action is likely to jeopardize a listed species or to destroy or adversely modify its critical habitat. If an action will result in jeopardy, the USFWS or NMFS will provide the consulting federal agency with reasonable and prudent alternative actions to avoid jeopardy. For any non-federal action otherwise prohibited by Section 9, the applicant must apply to the Secretaries for an incidental take permit under ESA Section 10. (16 U.S.C., § 1539.) Species that are candidates for listing are not protected under ESA; however, USFWS advises that a candidate species could be elevated to listed status at any time, and, therefore applicants should regard these species with special consideration.

Recovery Plan for Upland Species of California

The *Recovery Plan for Upland Species of California* (Recovery Plan) was released by USFWS in 1998. This plan addresses 34 species of plants and animals that occur in the San Joaquin Valley that are either federally listed as threatened or endangered, or are candidates for listing or species of concern. The ultimate goal is to delist the 11 endangered and threatened species addressed in the plan and ensure the long-term conservation of the other 23 species (USFWS 1998). The plan provides for both an ecosystem approach and a community-level strategy to conservation planning. USFWS also uses the plan to determine recommendations and requirements during endangered species consultation for these species. The Recovery Plan should be taken into consideration when analyzing potential impacts on upland natural community habitats in the San Joaquin Valley to ensure that projects do not prevent or impair the future long-term implementation success of the Recovery Plan.

National Wildlife Refuge System Improvement Act of 1997

Comprehensive Conservation Plans (CCP) are required under the National Wildlife Refuge System Improvement Act of 1997 and are prepared by USFWS. In 2006 the USFWS prepared a final CCP for the SJR National Wildlife Refuge to guide the management of the refuge for the next fifteen years. The primary goals of the CCP are: conserve and protect the natural diversity of migratory birds, resident wildlife, fish, and plants through restoration and management of riparian, upland, and wetland habitats on refuge lands; contribute to the recovery of threatened/endangered species, as well as the protection of populations of special-status wildlife and plant species and their habitats; provide optimum wintering habitat for Aleutian Canada geese to ensure their continued recovery; coordinate the natural resource management of the SJR National Wildlife Refuge in the context of the larger Central Valley/San Francisco ecoregion; provide the public with opportunities for compatible, wildlife-dependent visitor services to enhance understanding, appreciation, and enjoyment of natural resources at the SJR National Wildlife Refuge. As identified by Table 8-2 there are several national wildlife refuges, with CCPs, that receive surface water from either the three eastside tributaries or the LSJR. They include: SJR National Wildlife Refuge, Merced National Wildlife Refuge, and the San Luis National Wildlife Refuge.

Federal Power Act

Under the Federal Power Act (FPA), the Federal Energy Regulatory Commission (FERC) is responsible for determining under what conditions to issue licenses, or relicense, non-federal hydroelectric projects. Under the provisions of Section 10(j) of the FPA, each hydroelectric license issued by FERC is required to include conditions for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. These required conditions are to be based on recommendations of federal and state fish and wildlife agencies. FERC may reject or alter the recommendations on several grounds, including if FERC determines they are inconsistent with the purposes and requirements of the FPA or other applicable law. The State Water Board exercises authority over hydropower projects through Section 401 of the Clean Water Act, which requires an applicant for a federal license or permit that conducts an activity that results in a discharge into the navigable waters of the United States to apply for a certification from the state that the discharge will comply with state and federal water quality standards. The certification will include conditions requiring compliance with the Bay-Delta Plan's water quality objectives, including the LSJR flow requirements. FERC does not have authority to review or set aside the water quality certification.

Additionally, under FPA Section 4(e), federal land management agencies can also require measures for the protection, mitigation and enhancement of fish and wildlife resources, including for the protection of terrestrial habitat. BLM is the primary federal land management agency with mandatory conditioning authority under the FPA for federal land around Lake McClure and New Don Pedro Reservoir. In many instances, this has resulted in hydropower operators regulated by FERC developing invasive species management plans and other wildlife management plans.

8.3.2 State

Relevant state programs, policies, plans, or regulations related to terrestrial biological resources are described below.

California Endangered Species Act of 1970

CESA (Fish & G. Code, § 2050 et seq.; Cal. Code Regs, tit. 14, § 783 et seq.) expresses state policy to conserve, protect, restore, and enhance any endangered or threatened species or its habitat. Under CESA, the California Fish and Game Commission has the responsibility for maintaining a list of threatened and endangered species. (Fish & G. Code § 2070.) CESA generally prohibits *take* (defined, in part, as hunt, pursue, catch, capture, or kill) of listed species, although it may allow for take incidental to otherwise lawful activities. (Fish & G. Code, § 2080 et seq.) CDFW also maintains lists of species of special concern that are intended to designate species at conservation risk, stimulate research on poorly known species, and achieve conservation and recovery of species before they are listed under CESA.

Protections under Other Provisions of the California Fish and Game Code

California Fish and Game Code Section 1385 et seq. (known as the California Riparian Habitat Conservation Act) requires that the preservation and enhancement of riparian habitat shall be a primary concern of state agencies whose activities impact riparian habitat. (Fish & G. Code, § 1389.) The California Fish and Game Code also designates certain mammal, amphibian, reptile, fish, and bird species as “fully protected,” making it unlawful to take or possess these species except under certain circumstances. Limestone salamander, which is present around Lake McClure, is a fully protected species. (Fish & G. Code, §§ 3511 [birds], 4700 [mammals], 5050 [reptiles and amphibians], 5515 [fish].) According to CDFW, most fully protected species have also been listed as threatened or endangered. California Fish and Game Code Sections 3503, 3503.5, and 3800 prohibit the possession, take, or needless destruction of the nests or eggs of any bird, and the take of any nongame bird.

California Native Plant Protection Act of 1977

The California Native Plant Protection Act of 1977 (Fish & G. Code, § 1900 et seq.) gives the Fish and Game Commission the authority to designate native plants as endangered or rare, and prohibits the take of designated plants with some exceptions.

California Invasive Species Plans

There are several state invasive species plans used to control the infiltration of invasive species and reduce their prevalence. Various state agencies, including CDFW, the California Department of Food and Agriculture (CDFA), California Department of Parks and Recreation, and California State Lands Commission, have oversight over invasive species. Existing state invasive species control programs include the following.

- The California State Parks Division of Boating and Waterways (CDBW) is the lead agency for the survey and control of Brazilian waterweed, water hyacinth, and South American spongeplant in the Delta, its tributaries, and the Suisun Marsh.
- The Noxious Weed Information Project (NWIP), a product of CDFA, provides maps and other information for CDFA, biologists, and the general public (CDFA 2016).
- Cal-IPC’s mission is to protect California's lands and waters from ecologically-damaging invasive plants through science, education, and policy. Cal-IPC works closely with agencies, industry, and nonprofit organizations to support research, restoration work, and public education (Cal-IPC

2012). It also operates the CalWeedMapper online database that describes, maps, and identifies management opportunities for controlling invasive plants in California.

California Weed Management Areas

California's Weed Management Area (WMA) program was created in 1999 (Food & Agr. Code, § 7270 et seq.) to address the destructive impact of invasive and noxious weeds. CDFA reviews proposals from established weed management areas, which are local stakeholder groups working on weed projects, and awards funding. Weed management areas must have their goals and objectives defined in a strategic plan to receive funding.

The Sierra-San Joaquin Noxious Weed Alliance (Fresno, Madera, and Mariposa Counties) was formed in 1998 and leads programs targeting the early detection and eradication of noxious weeds, as well as specific programs targeting star thistle. The Central Sierra Partnership Against Weeds covers Calaveras and Tuolumne Counties. In Calaveras County, projects have focused specifically on the location and eradication of certain invasive species (Cal-IPC 2012).

8.3.3 Regional or Local

Relevant regional or local programs, policies, plans, or regulations related to terrestrial biological resources are described below. Although local policies, plans, or regulations are not binding on the State of California, below is a description of relevant ones.

San Joaquin County Multi-Species Habitat Conservation Plan

The *San Joaquin County Multi-Species Habitat Conservation and Open Space Plan* was approved in 2001. The geographic scope covers all of San Joaquin County and includes lands within the legal Delta boundary (County of San Joaquin 2000). The habitat conservation plan (HCP) is a 50-year plan and covers a wide variety of federal, state, and other special-status species in San Joaquin County. One of the primary goals of the HCP is to preserve open space, which includes wetland and riparian habitats. Participation in the HCP is voluntary for both local jurisdictions and project applicants. Only agencies adopting the HCP would be covered by the HCP. In addition, the HCP provides for agricultural conservation easements to support species. Approximately 13,000 acres have been entered into a conservation easement (SJCOG n.d). Approximately 64,000 acres is expected to be placed under conservation easements over the life of the permit for the HCP.

General Plans

General plans guide land development within their jurisdictions. Policies and objectives related to natural resources identified in local general plans typically complement state and federal regulations regarding biological resources and protect open space and native biotic communities. General plan policies related to terrestrial biological resources are summarized below.

Calaveras County

The Open Space Element of the *Calaveras County General Plan* addresses the relationship between open space and the protection of rare and endangered species and ecologically sensitive areas (Calaveras County 1996). Policy V-1A and Policy V-2A require review of proposed developments for potential impacts on significant habitats or potential to cause sedimentation of water bodies. Policy V-3A requires review of proposed development for potential impacts on riparian areas.

Tuolumne County

The *Tuolumne County General Plan* (1996) includes policies to maintain biological resource conservation programs (Policy 4.J.2), and support no net loss of wetlands (Policy 4.J.5) and other sensitive habitats (Policy 4.J.6).

Stanislaus County

The Conservation/Open Space Element (Chapter 3) of the *Stanislaus County General Plan* (Stanislaus County 1994) establishes goals and policies for the management of natural resources and the preservation of open space lands. Policy 3 protects sensitive wildlife habitat and plant life identified by the county or by state or federal agencies, Policy 4 protects woodlands and other native hardwood habitat, and Policy 30 protects the habitats of rare and endangered fish and wildlife species.

Merced County

Policies in the Open Space/Conservation chapter of the *Merced County General Plan* (1990) are primarily focused on development and land use. Specific policies ensure adequate protection and monitoring of development projects near rare and endangered species habitats and protect significant aquatic and waterfowl habitats from excessive water withdraws.

Mariposa County

The *Mariposa County General Plan* (2006) outlines programs for the management and conservation of natural resources, including water conservation to sustain riparian communities (Policy 11-2d). The diversity of native ecosystems and plant and animal species in the county is preserved through the Mariposa County Environmental Conservation Program, standards that reduce or eradicate invasive species, and compliance with state and federal regulations (Policy 11-4a).

San Joaquin County

The *San Joaquin County General Plan* includes open space policies that protect resource areas from adverse impacts of development, including protection of habitat for threatened, rare, and endangered species. The County requires that water projects incorporate safeguards for fish and wildlife, and stipulates that no public action shall significantly diminish the county’s wildlife and vegetative resources. The plan protects strips of habitat along waterways and encourages the restoration and enhancement of degraded ecosystems (County of San Joaquin 1992).

8.4 Impact Analysis

This section identifies the thresholds of significance criteria used to evaluate the potential impacts on terrestrial biological resources. It further describes the methods of analysis used to evaluate the potential impacts and to determine the significance of those impacts. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

8.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) Terrestrial biological impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and therefore are discussed in this analysis. The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) In this chapter, Impact BIO-3, involving invasive plants and nonnative wildlife, is an additional potential impact meriting analysis as to whether the alternatives could result in the following.

- Have a substantial adverse effect on any riparian habitat or other sensitive natural terrestrial communities identified in local or regional plans, policies, or regulations or by CDFW or USFWS.
- Have a substantial effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.
- Facilitate a substantial increase in distribution and abundance of invasive plants or nonnative wildlife that would have a substantial adverse effect on native terrestrial species.
- Have a substantial adverse effect, either directly or through habitat modifications, on any terrestrial animal species identified as a candidate, sensitive, or special-status in local or regional plans, policies, or regulations or by CDFW or USFWS.
- Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan or conflict with any local policies or ordinances protecting biological resources.

Where appropriate specific quantitative or qualitative criteria are described in Section 8.4.2, *Methods and Approach,* for evaluating these thresholds.

As discussed in Appendix B, the LSJR and SDWQ alternatives would result in either no impact or less-than-significant impacts on the following related to terrestrial biological resources and, therefore, are not discussed within this chapter.

- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.

8.4.2 Methods and Approach

This section describes the methods and approach for analyzing the LSJR and SDWQ alternatives.

LSJR Alternatives

This chapter evaluates the potential biological terrestrial impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow[5] requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K. Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is

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[5] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.

4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cubic feet per second (cfs) may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water. For example, terrestrial riparian species could benefit by receiving additional flows during key germination times in the late spring.

Information from Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and results from the State Water Board's Water Supply Effects (WSE) model presented in Chapter 5, *Surface Hydrology and Water Quality,* and Appendix F.1, *Hydrologic and Water Quality Modeling,* was reviewed. The quantitative results included in the figures, tables, and text of this chapter present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). This chapter also incorporates a qualitative discussion of adaptive implementation under each of the LSJR alternatives that includes the potential environmental effects associated with adaptive implementation.
To inform the qualitative discussion and account for the variability allowed by adaptive implementation, modeling was performed to predict conditions at 30 percent and 50 percent of unimpaired flow (as reported in Appendix F.1). The modeling also allows some inflows to be retained in the reservoirs until after June, as could occur under method 3, to prevent adverse temperature effects. This variety of modeling scenarios provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. This chapter incorporates a qualitative discussion of the potential terrestrial biological resource impacts of adaptive implementation under each of the LSJR alternatives. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1.

Rivers

Plans, policies, and regulations reviewed in the preparation of this analysis have indicated that the area of potential effects includes a variety of riparian communities, freshwater marsh, and elderberry savanna (See Section 8.2.1, *LSJR and the Three Eastside Tributaries*; State Water Board 1999; USFWS 2012; Riparian Habitat Joint Venture 2004; Moyle and Bennett 2008; Moise and Hendrickson 2002; Sawyer et al. 2009; CDFG 2012, 2003). Impact BIO-1 focuses on potential impacts on riparian habitats in the context of the California Riparian Habitat Conservation Act. Impacts on freshwater marsh are discussed in Impact BIO-2. Impacts on the elderberry savanna are not further considered because this community occurs on floodplains (USBR 2010a), and some increased inundation as a result of the LSJR alternatives (Chapter 6, *Flooding, Sediment, and Erosion,* Impact FLO-2) would be beneficial overall (as discussed under Impact BIO-4). However, individual elderberry shrubs are found in riparian vegetation and habitat within or near river channels that may be frequently inundated; as such, the effects on species relying on elderberry shrubs are included in Impact BIO-4.

General trends identified in the WSE for the LSJR alternatives are used in the analysis to qualitatively evaluate impacts on terrestrial biological resources. Annual averages or monthly averages for flow in each river are used where appropriate. In addition, as described in Chapter 5, *Surface Hydrology and Water Quality,* Section 5.4.3, the cumulative distribution[6] of flows for February–June are also used to compare baseline conditions to LSJR alternative conditions. The cumulative distribution of flows is used because they provide an accurate summary of the range of flows expected over a number of years. The comparison of monthly cumulative distributions of flows, in conjunction with the individual monthly average changes in flow, provides an appropriate measure of hydrologic changes resulting from the LSJR alternatives. Therefore, this information is used to evaluate the expected type of terrestrial habitat conditions under baseline and LSJR alternative conditions (see Appendix F.1, *Hydrologic and Water Quality Modeling*, Sections F.1.3 and F.1.4, for additional information and summary data regarding cumulative distributions). These trends are summarized below.

- For LSJR Alternative 2, modeled monthly flows on the Stanislaus River were generally similar to baseline flows, although with some small shifting of flows from March to June. Flows for the Merced and Tuolumne Rivers and the LSJR were generally similar to or greater than baseline flows, depending on the month (Tables 5-16 and 5-17a, 5-17b, 5-17c, and 5-17d).
- For LSJR Alternatives 3 and 4, modeled monthly flows would generally increase relative to baseline flows on the Merced, Tuolumne, and Stanislaus Rivers and the LSJR (Tables 5-16 and 5-17a, 5-17b, 5-17c, and 5-17d). In most cases, these rivers would experience substantial increases in median flows from February–June relative to baseline.
- For LSJR alternatives 3 and 4, modeled results indicated occasional reductions in the highest flows caused by a reduced need for flood control releases when compared to baseline conditions. Flood control releases were most likely to occur when the reservoirs were filling

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[6] The cumulative distribution of a particular variable (i.e., reservoir elevations) provides a basic summary of the distribution of values. This term is not referring to, and should not be confused with, the term cumulative impacts, which is a specific CEQA term. A discussion of cumulative impacts for CEQA purposes is provided Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*; Chapter 16, *Evaluation of Other Indirect and Additional Actions;* and Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

with storm flows or when the reservoirs had to be emptied in the fall in preparation for storms in winter and spring. Flood control releases occurred more often in wet years and were more common at Don Pedro Reservoir and Lake McClure (i.e., the two smaller reservoirs). During wet years, reservoir releases were greater under LSJR Alternatives 3 and 4, so reservoir storage would reach the maximum allowed limit less often and flood control releases would not be needed as much.

- The largest changes in flow associated with the LSJR alternatives occurred from February–June, but there were some smaller effects outside of this period. Changes from July–January were primarily related to changes in flood control releases, retention of unimpaired flow for later release in the fall as part of adaptive implementation described under the LSJR alternatives in Section 8.4.3, *Impacts and Mitigation Measures*, during wet conditions, and retention of water in the reservoirs to maintain carryover storage (by reducing diversions in dry years).
- Actions required by the NMFS BO (Stanislaus River reasonable and prudent alternative, including Action 3.1.3), are included in the baseline for modeling purposes. Under the modeled conditions of the LSJR alternatives, these flows would be met or exceeded. The WSE modeling of the LSJR alternatives assumes that a certain percent of unimpaired flow would be met. However, if the NMFS BO flows are higher than the percent unimpaired flow, then the NMFS BO flow becomes the target flow.

Modeling results predict that LSJR Alternatives 3 and 4 would increase flows on the LSJR February–June. These flows would be distributed between Old River, Middle River, and the SJR downstream of Vernalis and would contribute to an environment that is also affected by water diversions, tidal action, and Sacramento River inflow. Flows caused by the LSJR alternatives would largely be confined within existing channels. Therefore, as described in Chapter 6, there would not be a significantly increased risk of flooding. Also, the effects of Alternatives 3 and 4 on water surface elevation in the southern Delta would be relatively small because water surface elevation in much of the region is dominated by tidal effects. Any increase in elevation of the groundwater table or seepage that may result from higher water levels would be small and would tend to benefit native terrestrial Delta species. Therefore, this analysis does not consider potential impacts of the LSJR alternatives below Vernalis.

Reservoirs

Baseline conditions and LSJR alternative water surface elevations for the three reservoirs (New Melones, Don Pedro, and Lake McClure), are presented in Appendix F.1, *Hydrologic and Water Quality Modeling* (Tables F.1.3-5c, F.1.3-5i, F.1.3-5m, F.1.3-6b, F.1.3-6f, F.1.3-6j, F.1.3-7b, F.1.3-7f, F.1.3-7j, F.1.3-8b, F.1.3-8f, F.1.3-8j). Vegetation along the shores of New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure, as well as birds and other wildlife that may use the reservoirs, are accustomed to fluctuations in reservoir elevation that occur under baseline conditions. WSE results for baseline conditions indicate that for most years there are large fluctuations in water surface elevations in the three reservoirs. The median range between the yearly minimum and maximum elevations over the 82-year baseline simulation was 63 ft for New Melones Reservoir, 54 ft for New Don Pedro Reservoir, and 88 ft for Lake McClure. New Melones Reservoir minimum fluctuation range is 24 ft and its maximum fluctuation range is 232 ft ; New Don Pedro Reservoir minimum fluctuation range is 25 ft and maximum fluctuation range is 151 ft ; and Lake McClure's minimum fluctuation range is 29 ft and maximum fluctuation range is 320 ft . Because terrestrial biological resources that use the reservoirs are accustomed to large interannual and annual variations in the reservoirs' water surface elevation that occur as part of normal reservoir operations, small changes in reservoir elevations are unlikely to affect terrestrial biological resources. Tables 8-7a, 8-7b, and 8-7c characterize the potential water surface fluctuations under the LSJR alternatives. For the purpose of comparison, the tables summarize the percent of time the reservoirs would fluctuate more than 10 ft from one month to the next. The results show that the fluctuation of water surface elevations under the LSJR alternatives is expected to be similar to baseline conditions.

This information was presented to qualitatively evaluate direct and indirect impacts on terrestrial biological resources as a result of the implementation of the LSJR alternatives in Impacts BIO-1 through BIO-5. Direct impacts were defined as actions that were likely to result in immediate plant or animal mortality or complete habitat loss. Indirect impacts were defined as delayed effects, nonfatal stresses upon plants and animals, and/or habitat degradation.

LSJR Alternatives and the Southern Delta

Habitats and the dominant terrestrial wildlife and plant species in the southern Delta tolerate fluctuations in salinity and regularly experience tidal influences and salinity inputs from other sources (e.g., upstream sources). Salinity in the southern Delta generally ranges between 0.2 dS/m and 1.2 dS/m during all months of the year, and salinity at Vernalis is almost always below the current objective (maximum 30-day running average of 0.7 from April through August or 1.0 dS/m from September through March). In addition, a strong relationship is observed between salinity at Vernalis and salinity in the southern Delta; the measured EC[7] at Brandt Bridge is increased by a maximum of 0.2 dS/m above the Vernalis salinity (Figure F.1.5-2a) and is increased by a maximum of 0.4 dS/m at Tracy Boulevard (Figure F.1.5-2b). The volume of water needed to meet the Vernalis EC objective is included in the WSE modeling results and, therefore, is in the impact determinations for the LSJR alternatives. This information is used to qualitatively assess the effects of the LSJR alternatives on water quality, specifically salinity, in the southern Delta with respect to terrestrial habitat and species (Impacts BIO-1 and BIO-4).

Area of Potential Indirect Effects

Agricultural practices and land cover depend on a wide variety of factors, including the unique circumstances and decisions made by farmers in the plan area, market conditions, and the location of different agricultural properties and crops; therefore, this chapter provides a qualitative evaluation of potential indirect effects on sensitive wildlife species and habitat resulting from a reduction of irrigation water supply to agricultural fields using information regarding agricultural land cover and practices. Habitat requirements for San Joaquin Valley representative, or keystone species, such as blunt nosed leopard lizard, San Joaquin kit fox, and Swainson's hawk are discussed in the context of potential changes in agricultural land cover that could occur in the area of potential indirect effects. A qualitative discussion of the potential for invasive species to occur as a result of reduced irrigation water supply is also discussed.

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[7] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

The habitats and the dominant terrestrial wildlife and plant species in the southern Delta tolerate fluctuations in salinity and regularly experience tidal influences and salinity inputs from other sources (e.g., upstream sources). Therefore, terrestrial biological resources in the Southern Delta can only be significantly affected if salinity levels change so substantially that existing habitat or plants could not survive. As discussed in Chapter 5, *Surface Hydrology and Water Quality*, the existing water quality in the southern Delta generally ranges between 0.2 dS/m and 1.2 dS/m during all months of the year. In addition, there is a strong relationship between salinity at Vernalis and salinity in the southern Delta, which increases by a maximum of 0.4 dS/m above the Vernalis salinity at locations downstream.

The program of implementation for the SDWQ alternatives would still include the requirement for USBR to maintain salinity at Vernalis in accordance with its water rights. Therefore, the SDWQ alternatives are not expected to affect the overall quantity or quality of the habitats in the southern Delta. Exact data on the salt tolerance of individual plant species present in the Delta is not readily available and depends on a host of interrelated factors. However, native Delta plant species are adapted to brackish waters and salinity levels that have historically existed in the southern Delta. Additionally, periodic salinity intrusion into the Delta may help to reduce the abundance and/or distribution of certain harmful invasive species and give native species a competitive advantage (Carter and Nippert 2012). There is no mechanism for the SDWQ alternatives, which would only modify the salinity objectives, to result in fill or physical modification of wetlands that occur within the southern Delta.

The modeling results indicated that under SDWQ Alternatives 2 or 3, exceedances (described in Section 8.3.2, *State [Regulatory Background]*) would not increase relative to baseline and the salinity in the LSJR and southern Delta would remain similar to baseline or be reduced (Appendix F.1, Section F.1.5.2, *Salinity Modeling Results*). As a result, there is limited potential for the SDWQ alternatives to impact terrestrial species in the southern Delta as salinity in the southern Delta would remain within the historical range, and the terrestrial plant and animal species can adapt to the variable salinity levels that the southern Delta currently experiences. Consequently, there would be little to no change from baseline; therefore, the SDWQ alternatives are not discussed further in this chapter. However, to comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on biological resources. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

Table 8-7a. Percent of Time Water Surface Elevation Fluctuation Greater than 10 Feet from Month to Month for New Melones Reservoir

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Baseline % Fluctuation	5	1	16	24	34	26	28	52	46	62	68	10
LSJR Alternative 2 Fluctuation	2	1	10	21	29	20	15	38	30	52	60	6
LSJR Alternative 3 Fluctuation	5	1	12	27	24	21	11	27	17	34	34	4
LSJR Alternative 4 Fluctuation	6	2	13	28	15	11	9	21	4	21	23	5

Note: lower percentages indicate less fluctuation greater than 10 feet occurring at a reservoir.

Table 8-7b. Percent of Time Water Surface Elevation Fluctuation Greater than 10 Feet from Month to Month for New Don Pedro Reservoir

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Baseline % Fluctuation	0	2	15	17	28	20	10	32	55	79	96	6
LSJR Alternative 2 Fluctuation	0	2	17	18	29	21	9	27	45	78	91	4
LSJR Alternative 3 Fluctuation	1	4	22	27	34	28	5	22	33	73	78	18
LSJR Alternative 4 Fluctuation	2	4	23	28	28	24	5	28	17	22	48	13

Note: lower percentages indicate less fluctuation greater than 10 feet occurring at a reservoir.

Table 8-7c. Percent of Time Water Surface Elevation Fluctuation Greater than 10 Feet from Month to Month for Lake McClure

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Baseline % Fluctuation	44	10	15	24	33	52	57	80	38	96	98	93
LSJR Alternative 2 Fluctuation	32	1	9	17	27	46	56	74	32	93	95	79
LSJR Alternative 3 Fluctuation	43	4	16	23	29	48	48	71	20	88	91	67
LSJR Alternative 4 Fluctuation	35	10	18	27	28	39	26	48	22	60	90	49

Note: lower percentages indicate less fluctuation greater than 10 feet occurring at a reservoir.

8.4.3 Impacts and Mitigation Measures

Impact BIO-1: Have a substantial adverse effect on any riparian habitat or other sensitive natural terrestrial communities identified in local or regional plans, policies, or regulations or by CDFW or USFWS

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 *Water Quality Control Plan for the San Francisco/Sacramento–San Joaquin Delta Estuary* (2006 Bay–Delta Plan). See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Riparian habitats are tolerant of seasonal fluctuations in river flows. Adaptations, such as extremely rapid life cycles that maximize opportunities for replenishment of the soil seed bank prior to subsequent inundation flooding or the onset of drought, allow for species to thrive in variable environments (Capon and Dowe 2006). Despite this tolerance of variability, exceptionally low summer stages (drought) or high water stages year-round can lead to desiccation or inundation mortality, respectively, and are two of the major drivers affecting the composition and success of sensitive habitats and plant species along rivers. In general, unimpaired flow regimes are more seasonally variable. The result of flow regulation has, in many cases, been a reduction in vegetation heterogeneity that has led to eventual loss of biodiversity (Capon and Dowe 2006).

Most riparian vegetation within the area of potential effects is riparian forest or willow scrub. The typical dominant species of these habitats (e.g., sandbar willow) are particularly resistant to damage by scour or burial (USBR 2010a). In addition, scour and deposition of sediment can sustain floodplain habitats and create opportunities for plant establishment, thus sustaining the diversity of riparian vegetation.

In many locations and times of year throughout the area of potential effects, the LSJR alternatives could increase surface water or groundwater elevations, potentially resulting in submergence of the root zones and aboveground aspects of vegetation. This condition may cause dieback of nonnative and upland species that are not adapted to periodic inundation, while an increase in water availability during the growth period for riparian vegetation (generally late spring to early fall) could encourage the growth of native species. Additionally, it is expected that the LSJR alternatives could periodically inundate some areas that do not currently support riparian vegetation. This periodic inundation could create conditions suitable for dispersal and establishment of riparian plants through sediment deposition, water transport of plant seeds and fragments to new locations, increased water availability, and reduced competition from upland plant species (e.g., nonnative grasses) that are intolerant of prolonged submergence. Certain plants, such as deep-rooted trees, are more likely to persist in variable environments because they are able to access groundwater (Capon and Dowe 2006). Therefore, manipulation of flow regimes during critical seasons can potentially augment recruitment and survival of riparian tree species, particularly willows and cottonwoods (Moise and Hendrickson 2002). Activities that support the establishment and success of native species are generally consistent with the goals and policies contained in the SJR National Wildlife Refuge CCP, the San Joaquin County Multi-Species HCP, and applicable general plans.

The ability of a reservoir to support riparian vegetation is a function of reservoir size (larger reservoirs generally have a greater circumference and, therefore, more potential for hydrologic connectivity), adjacent land use, and the speed and frequency at which drawdown occurs. Riparian plants are typically resilient to changes in reservoir levels (Waring 1992). Other habitat features like the presence of small tributaries entering the main reservoir can create small areas of wetland and riparian habitats around the reservoir edge. Riparian habitats at the reservoirs in the area of potential effects are currently subject to fluctuating water levels (see Tables 8-7a, 8-7b, and 8-7c for the expected changes in water level fluctuation for each reservoir). Furthermore, in many cases there is a lack of vegetation in the zone of fluctuation created by variations in water surface elevation. Within this zone, it is difficult for plant species (e.g., riparian or other sensitive plant species) to fully establish because of the propensity for flooding and loss of topsoil from wave erosion however some areas of wetland and riparian habitat have been established (Merced ID 2011a). Shore erosion may occur at all water surface elevations but is generally most severe when water surface elevations change rapidly (Baird and Associates 2004). Water surface elevation fluctuations at the major rim reservoirs tend to follow seasonal patterns, with high water levels occurring during the late spring and early summer and progressively lower water levels occurring during the late summer and fall.

Habitats and the dominant terrestrial wildlife and plant species in the southern Delta tolerate fluctuation in salinity and regularly experience tidal influences and salinity inputs from other sources (e.g., upstream sources). Exact data on the salt tolerance of individual plant species present in the Delta are not readily available and depend on a host of interrelated factors. However, native Delta plant species are adapted to brackish waters and salinity levels that have historically existed in the southern Delta as described above in Section 8.4.2, *Methods and Approach*, and in Chapter 5, *Surface Hydrology and Water Quality*. Additionally, periodic salinity intrusion into the Delta may help to reduce the abundance and/or distribution of certain harmful invasive species and give native species a competitive advantage (Carter and Nippert 2012).

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Rivers

The modeling results indicate that under LSJR Alternative 2, the Stanislaus River would experience median flows similar to baseline flows (Table 5-16 and 5-17c). The largest changes in median flow associated with LSJR Alternative 2 relative to baseline in the Stanislaus River were a decrease of 15 percent in March and an increase of 24 percent in June. The overall cumulative distribution of the flows (i.e., the range of flows distributed between the minimum flow [thousand acre-feet] and the maximum flow over the entire 82-year historic modeling period) would be similar under LSJR Alternative 2 when compared to baseline conditions (Table 5-16 and 5-17c). This means that the total volume of water available February–June on the Stanislaus River would be similar when compared to baseline conditions. The baseline flows on the Stanislaus are high from February–June as a result of the Vernalis Adaptive Management Program flow requirements and the mandated pulse flows required by the NMFS BO; however, the flow requirements under LSJR 2 (the maximum of the NMFS BO flows or 20 percent of the unimpaired flow) produce river flows that are similar to baseline. Impacts on riparian habitat or other sensitive natural terrestrial communities would be less than significant.

Modeling results indicate that the median monthly flows would generally be very similar to or greater than baseline flows on the Tuolumne and Merced Rivers, and LSJR under LSJR Alternative 2. Furthermore, the overall volume of water described by the cumulative distribution of flows February–June would be slightly greater than baseline (Table 5-16 and 5-17a, 5-17b, and 5-17d). Therefore, significant impacts on riparian vegetation or other sensitive plant communities on the Tuolumne and Merced Rivers and LSJR are not expected. Impacts would be less than significant.

Scour and deposition of sediment would not be expected to adversely affect riparian vegetation because riparian scrub is tolerant of these types of physical processes. Furthermore, flows under LSJR Alternative 2 on all three eastside tributaries and the LSJR are not expected to result in substantial bed mobilization or channel modification, as discussed in Chapter 6, *Flooding, Sediment, and Erosion*, Section 6.4.3, *Impacts and Mitigation Measures*, and Chapter 7, *Aquatic Biological Resources*, Section 7.4.3, *Impacts and Mitigation Measures*, when compared to baseline conditions. For these reasons, significant impacts on riparian communities and other sensitive plant communities are not expected. Impacts would be less than significant.

Reservoirs

Under LSJR Alternative 2, all three reservoirs would generally experience little change or a decrease in substantial water surface elevation fluctuations (i.e., fluctuations greater than 10 ft) relative to baseline (Tables 8-7a, 8-7b, and 8-7c). This would result in a more stable nearshore environment. A decrease in the fluctuation of reservoir water surface elevation may permit some vegetation establishment in the zone of fluctuation. However, such colonization would be limited by substrate suitability because these nearshore areas often lack topsoil in the zone of historical fluctuation due to erosion caused by existing surface water elevation changes and wave action. The changes in surface water elevation fluctuation expected under the LSJR alternatives at Lake McClure are not expected to adversely impact habitat for limestone salamander. Riparian habitat or other sensitive plant communities at the reservoirs are not expected to be substantially altered because established riparian habitat, terrestrial communities, and special-status plant species are also sustained by groundwater and are adapted to brief changes in water surface elevations at the reservoirs. Impacts on riparian habitat, other sensitive terrestrial plant communities, or special-status plant species at the reservoirs would be less than significant.

Southern Delta

Modeled results indicate that EC values in the southern Delta could increase or decrease depending on which SDWQ Alternative is implemented (Tables 5-25 and 5-26a, 5-26b, and 5-26c), but overall salinity in the southern Delta would be slightly reduced (Tables 5-29a, 5-29b, and 5-29c) under LSJR Alternative 2. These changes with respect to terrestrial habitat would be very small, if imperceptible. April–September is the irrigation season when, historically, salinity increases as a result of agricultural irrigation runoff. Tables 5-29a, 5-29b, and 5-29c indicate that the change in the April–September (irrigation season) EC values are generally small. Of the three sites evaluated, the largest changes are expected to occur in Old River at Tracy Boulevard. Table 5-29c indicates that the largest changes in the April–September (irrigation season) EC distribution at Tracy Boulevard from baseline to LSJR Alternative 2 was a reduction in the maximum values of 0.62 dS/m (1.038–0.977

dS/m). These changes with respect to terrestrial habitat would be very small, if measurable at all, because riparian habitat plant species in the southern Delta tolerate variable salinity conditions. Therefore, LSJR Alternative 2 is not expected to impact the overall quantity or quality of the habitats in the southern Delta, and impacts would be less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20 percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20 percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. The increased flows would potentially benefit riparian habitat because increased water levels during the late spring early summer months would entail a longer growing season with water levels at higher elevations, and as such would promote additional riparian vegetation recruitment at higher elevations along the steam banks and channels.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June timeframe. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. As such, flows would not substantially decrease with respect to baseline conditions and would not substantially affect any riparian habitat or other sensitive natural terrestrial communities.

Adaptive implementation method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent.

Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. WSE results show that under LSJR Alternative 2 the 1,200 cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 2.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required 0.7 percent of the time to meet a 1,000 cfs requirement and 0.5 percent of the time for an 800 cfs Vernalis base flow requirement. These results indicate that changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR. As such, flows under adaptive implementation method 4 would not substantially decrease with respect to baseline conditions and would not substantially affect any riparian habitat or other sensitive natural terrestrial communities.

Impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3. With method 1, if the specified percent of unimpaired flow were changed from 20 percent to 30 percent on a long-term basis, the conditions and impacts could become more similar to those described under LSJR Alternative 3. It is anticipated that over time the unimpaired flow requirement could increase or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. If method 2 is implemented, the total annual volume of water associated with LJSR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change. As a result, the total volume of water that would remain in the river would not change with adaptive implementation method 2 and impacts associated with total volume of water would not change. Terrestrial biological resources, such as riparian species that are dependent on the timing or magnitude of flow, could potentially be affected by method 2. This method would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR. As such, impacts would be similar to those described above for LSJR Alternative 2 without adaptive implementation. Implementing method 4 is expected to have little effect on conditions in the three eastside tributary rivers and LSJR because it rarely would cause a change in flow and the volume of water involved would be relatively small. Consequently, the impact determination of LSJR Alternative 2 with adaptive implementation would be the same as described for LSJR Alternative 2 without adaptive implementation. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Rivers

Modeled results indicate LSJR Alternative 3 would generally result in higher monthly flows on the Stanislaus, Merced, and Tuolumne Rivers and the LSJR (Tables 5-16 and 5-17a, 5-17b, 5-17c, and 5-17d). In most cases, these rivers would experience substantial increases in median flows from February–June under LSJR Alternative 3 relative to baseline. Changes during other months would be smaller. In some limited instances, LSJR Alternative 3 would result in reducing/peak flows when compared to baseline, primarily as a result of a reduced need for flood control releases.

Riparian habitat generally would not experience lower flows than they currently do under baseline conditions as a result of this alternative. Plants persisting in riparian habitats are adapted to survive periodic episodes of fluvial (high flow) disturbance (Capon and Dowe 2006). Therefore, any expected higher flows under this alternative would have limited potential to submerge existing vegetation frequently enough and long enough to result in impacts on native riparian plant communities or special-status plant species. The flows modeled for LSJR Alternative 3 are such that riparian vegetation is expected to adjust to the new flow regime (State Water Board 1999).
Any increase in flows would be expected to ultimately result in a net increase in acreage and diversity of riparian and emergent wetland vegetation, depending on the degree of channelization of the river and the encroachment of conflicting land uses. Increasing flows would result in occasional wetting of channels that are typically dry under current conditions and would have potentially beneficial effects. This may promote the natural process of succession, during which willow riparian forest may transition to valley oak riparian forest. Vegetation that has been established in the channel during low baseline flows may be eliminated. Although the alternative may result in a measurable shift in riparian habitats, compositional changes in this dynamic habitat would not be adverse. These changes would support the establishment and persistence of riparian and wetland vegetation. Furthermore, as described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, periodic high flows promote regeneration of riparian habitats. In periods of inundation during spring nonflood releases, floodplains and side channels may be inundated, and surface or groundwater would be accessible to plants over a greater area than at present. Riparian tree species along these rivers have evolved life

history strategies that depend on the river's historical hydrology, including the annual cycles of winter floods and spring snowmelt, as well as infrequent large spring floods (Stillwater Sciences 2003b). The limited instances of lower flows when compared to higher baseline flow conditions on the three eastside tributaries and the LSJR under this alternative are not expected to adversely affect riparian habitat because these reductions generally occur when flow is high and are associated with flood control conditions. Thus, they are not expected to cause a lack of water needed to support riparian vegetation. Therefore, when considering the expected increase in flows and the limited instances in which there would be a reduction in flows, it is not expected that there would be significant impacts on riparian communities and other sensitive plant communities. Impacts would be less than significant.

Reservoirs

The frequency and range in fluctuations of water surface elevations at the reservoirs would generally decrease or remain similar to baseline conditions and generally would not experience a significant increase in fluctuations greater than 10 ft throughout the year (Tables 8-7a, 8-7b, and 8-7c). From December–March, there would be small increases in reservoir elevation fluctuations—greater than 10 ft (increases of 5 percent or less)—at New Don Pedro Reservoir and Lake McClure, but in other months, these fluctuations would decrease relative to baseline. As described above for LSJR Alternative 2, conditions in the zone of fluctuation would generally remain similar to those under baseline conditions at the reservoir, in part because the disturbed substrate would provide limited opportunities for additional vegetation establishment. Impacts on riparian habitat or other sensitive terrestrial communities, such as habitat for limestone salamander around Lake McClure and the Red Hills and Bagby Serpentine ACECs, or special-status plant species would be less than significant.

Southern Delta

Modeled results indicate that EC values in the southern Delta would decrease (Table 5-25 and Tables 5-27a, 5-27b, and 5-27c), and overall salinity in the southern Delta would be reduced (Tables 5-29a, 5-29b, and 5-29c) under LSJR Alternative 3. These changes with respect to terrestrial habitat would be very small, if imperceptible. Therefore, LSJR Alternative 3 is not expected to impact the overall quantity or quality of the habitats in the southern Delta. Impacts would be less than significant.

Adaptive Implementation

Under LSJR Alternative 3, impacts associated with adaptive implementation method 1 may be slightly different from those associated with adaptive implementation methods 2 and 3.

Implementing method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40 percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. Adaptive implementation method 1 could affect the amount of water available for water supply and the volume of water and level of flow in the LSJR and the three eastside tributaries. However, the frequency and duration of such a change is unknown. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively. It is anticipated that over time the unimpaired flow requirement could increase, decrease, or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. At those times of increased flows, 50 percent unimpaired flow would increase the volume of water in the LSJR and the three eastside tributaries compared to 40 percent unimpaired flow. This would potentially benefit riparian habitat because the increased water levels during the late spring early summer months would entail a longer growing season with water levels at higher elevations, and as such would promote additional riparian vegetation recruitment at higher elevations along the steam banks and channels.

Under adaptive implementation methods 2 or 3, the overall volume of water from the February–June time period or after June would be the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. Impacts associated with the total volume of water would not be affected by method 2 or 3, but terrestrial biological resources, such as riparian species, that are dependent on the timing or magnitude of flow could potentially be affected. Wetland resources are somewhat dependent on the timing or magnitude of flow; however these resources are adapted to natural flood and drought cycles. Higher flows under adaptive implementation method 1 would not exceed the higher range of flows that could be experienced under baseline for some water years. However, given that these two methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the LSJR, impacts would be similar to those described above for LSJR Alternative 3 without adaptive implementation. Finally, adaptive implementation method 3 is incorporated into the modeling; thus, the range of terrestrial biological effects is reflected in the results presented above for LSJR Alternative 3 without adaptive implementation.

Implementing method 4 is expected to have little effect on conditions in the three eastside tributary rivers. WSE results show that under Alternative 3 the 1,200 cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 1.2 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required only 0.2 percent of the time to meet either a 1,000 cfs or 800 cfs Vernalis base flow requirement. These results indicate that method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative.

Consequently the impact determination of LSJR Alternative 3 with adaptive implementation would be the same as described for LSJR Alternative 3 without adaptive implementation. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Rivers

Monthly flows on all three eastside tributaries and the LSJR would generally increase under LSJR Alternative 4 (Table 5-16 and 5-17a, 5-17b, 5-17c, and 5-17d). In most cases, these rivers would experience substantial increases in median flows from February–June under LSJR Alternative 4 relative to baseline. Changes during other months would be smaller. In some limited instances, LSJR Alternative 4 would result in a reduction in flow, and these reductions would affect the highest flows when compared to baseline.

The impacts under LSJR Alternative 4 for the increase in average flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would be the same as described above under LSJR Alternative 3. Therefore, when considering the expected increase in flows and the limited instances in which there would be a reduction in flows, significant impacts on riparian communities and other sensitive plant communities are not expected. Impacts would be less than significant.

Reservoirs

The frequency and range of water surface elevation fluctuations at the reservoirs would generally decrease or remain similar to baseline conditions such that there would not be a significant increase in month to month fluctuations greater than 10 ft (Tables 8-7a, 8-7b, and 8-7c). As described for LSJR Alternative 3, the disturbed substrate would provide limited opportunities for additional vegetation establishment. These modifications to riparian habitat or other sensitive terrestrial communities, such as habitat for limestone salamander around Lake McClure and the Red Hills and Bagby Serpentine ACECs, or special-status plant species would be less than significant.

Southern Delta

Modeled results indicate exceedances of the EC objectives in the southern would decrease (Table 5-25 and Tables 5-28a, 5-28b, and 5-28c), and overall salinity in the southern Delta would be reduced (Tables 5-29a, 5-29b, and 5-29c) under LSJR Alternative 4. These changes with respect to terrestrial habitat would be very small, if imperceptible. Therefore, LSJR Alternative 4 is not expected to impact the overall quantity or quality of the habitats in the southern Delta. Impacts would be less than significant.

Adaptive Implementation

Under LSJR Alternative 4, impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3.

Adaptive implementation method 1 would allow a decrease of up to 10 percent in the annual February–June 60 percent unimpaired flow (to 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. Adjusting the percent of unimpaired flow through adaptive implementation is not anticipated to result in impacts different than those identified under LSJR Alternative 3 because LSJR Alternative 3 includes 50 percent within its range of adaptive implementation.

Adaptive implementation methods 2 and 3 would manage flows from February–June or outside of that time period. Given that these two methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described above for LSJR Alternative 4 without adaptive implementation. Finally, method 3 is incorporated into the modeling; thus, the range of terrestrial biological effects is reflected in the results presented above for LSJR Alternative 3 without adaptive implementation.

Implementing method 4 is expected to have little effect on conditions in the three eastside tributary rivers and LSJR. WSE results show that under Alternative 4 the 1,200 cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 0.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required only 0.2 percent of the time to meet a 1,000 cfs requirement and is not affected at all for an 800 cfs requirement. These results indicate that method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative.

Consequently, the impact determination of LSJR Alternative 4 with adaptive implementation would be the same as described for LSJR Alternative 4 without adaptive implementation. Impacts would be less than significant.

Impact BIO-2: Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

The LSJR alternatives do not have the potential to significantly physically fill, divert, or isolate wetland communities and would not discharge dredged or fill material into waters of the United States (e.g., wetlands). Most potential effects on wetland communities as a result of a change in flows would be comparable to the effects of periodic flood flows that have occurred historically (Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*). The effects of these alterations on wetland vegetation would be similar to those previously described for riparian vegetation because wetland plants can also survive inundation, are resistant to the effects of scouring deposition, and are growth-limited by water availability (USBR 2010a). Many effects are beneficial, such as greater availability of water to support growth of riparian or wetland vegetation and the deposition of new sediment rich in organic material. The primary and most ecologically important difference from baseline flows would be the duration and seasonality of inundation; increased flows could inundate some areas for longer periods than baseline seasonal flows would. At the local level, these alterations could adversely or beneficially affect wetlands and riparian habitat, depending on site-specific hydrologic changes. In the long term, plant communities may shift in elevation or species composition to accommodate changes in river flows (USBR 2010a).

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Rivers

As described under Impact BIO-1, modeled monthly flows on the Stanislaus River are expected to be similar to baseline flows. Flows for the Tuolumne and Merced Rivers and the LSJR are expected to be generally similar to or generally greater than baseline flows, depending on the month. As a result, there would be no substantial adverse change to conditions supporting wetlands in the area of potential effects. Impacts would be less than significant.

Reservoirs

Under LSJR Alternative 2, reservoir levels would generally fluctuate at a similar or reduced frequency compared to baseline. There are no known significant assemblages of wetlands along the shores of the reservoirs that would be inundated as a result of changes in reservoir elevations. Any impacts from higher water levels would be temporary and would last only until the marsh habitat could respond by shifting in elevation and species composition to accommodate the changes. There are some wetlands and riparian habitat around the reservoirs within the zone of fluctuation; however, these areas are not expected to experience negative impacts due to LSJR Alternative 2 since water elevation fluctuations are not expected to change significantly compared to baseline conditions (Tables 8-7a, 8-7b, and 8-7c). There are also barren areas at the reservoirs because of the lack of suitable soil and the continued fluctuation of water surface elevations. More stable reservoir elevations may result in perennial water availability, which may benefit the establishment and maintenance of wetland vegetation along the shores of the reservoirs. Consequently, impacts would be less than significant.

Adaptive Implementation

As discussed in Impact BIO-1, adaptive implementation method 1 could result in higher flows during some times of the year than under the specified unimpaired flow requirement of 20 percent. However, it is anticipated that over time the unimpaired flow requirement could increase, decrease, or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. Adaptive implementation method 2 could result in a reallocation of flows between months. Wetland resources are somewhat dependent on the timing or magnitude of flow; however these resources are adapted to natural flood and drought cycles. Higher flows under adaptive implementation method 1 would not exceed the higher range of flows that could be experienced under baseline for some water years. But adaptive implementation method 2 is unlikely to cause flows to be less than baseline flows or to cause overall annual volumes that are released to be different from baseline because method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June minimum flow requirement; however, changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR. At the local level, these alterations could adversely or beneficially affect wetlands and riparian habitat, depending on site-specific hydrologic changes. In the long term, plant communities may shift in elevation or species composition to accommodate changes in river flows. Consequently the impact determination of LSJR Alternative 2 with adaptive implementation would be the same as described above for LSJR Alternative 2 without adaptive implementation. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Rivers

LSJR Alternative 3 would represent a change in the timing of river flows that would better correspond with the growth and dispersal periods for native wetland vegetation. These native wetland plant communities have evolved life history characteristics that coincide with the unimpaired flow patterns (Moyle and Bennett 2008; CDFW 2014a). LSJR Alternative 3 may encourage the establishment of wetlands and plant assemblages that mimic the original wetland ecosystems that existed before hydromodification. Furthermore, LSJR Alternative 3 is not expected to result in flows of higher velocity than are known to occur in the system or that would result in substantial scour (see Chapter 6, *Flooding, Sediment, and Erosion,* and Chapter 7, *Aquatic Biological Resources*). Impacts on wetland communities would be less than significant.

Reservoirs

Under LSJR Alternative 3, fluctuations in water surface elevation at the reservoirs would generally decrease or remain similar to baseline conditions and generally would not experience a significant increase in fluctuations greater than 10 ft throughout the year (Tables 8-7a, 8-7b, and 8-7c). Although there are no large wetland areas, there are small segments of wetland and riparian habitat along the shores of these reservoirs within the zone of water elevation fluctuation. These habitats are not expected to be negatively impacted by LSJR Alternative 3 since water surface elevation fluctuations would be similar to baseline conditions, and would not lead to further isolation of these small wetland areas. Therefore, LSJR Alternative 3 would not substantially alter or reduce wetland communities at the reservoirs. Impacts would be less than significant.

Adaptive Implementation

Similar to LSJR Alternative 2 with adaptive implementation methods 1, 2, and 4, LSJR Alternative 3 may result in some modifications, at the local level, to wetland assemblages. Adaptive implementation method 3 would keep the overall volume of water from the February–June time period or after June the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. Wetland resources are somewhat dependent on the timing or magnitude of flow but are also adapted to natural flood and drought cycles. Nevertheless, higher flows under adaptive implementation method 1 would not exceed the flows that could be experienced under normal operations for some water years. Given that method 3 would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described above for LSJR Alternative 3 without adaptive implementation. In the long term, plant communities may shift in elevation or species composition to accommodate changes in river flows. Consequently the impact determination of LSJR Alternative 3 with adaptive implementation would be the same as described above for LSJR Alternative 3 without adaptive implementation. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Rivers

As described above for LSJR Alternative 3, LSJR Alternative 4 flows are expected to better coincide with the growth and dispersal periods for native wetland vegetation (spring time) and not result in substantial scour. LSJR Alternative 4 would have a less-than-significant impact on existing wetland communities within the area of potential effects along the rivers.

Reservoirs

The reservoir water surface elevation levels are generally not expected to experience large fluctuations with any greater frequency than under baseline conditions (Tables 8-7a, 8-7b, and 8-7c). As described above, there are small segments of wetland and riparian habitat along the shores of the reservoirs within the zone of water elevation fluctuation. These habitats are not expected to be negatively affected by LSJR Alternative 4 because water surface elevation fluctuations are expected to be similar to baseline conditions and, therefore, would not lead to isolation of these small wetland areas. Impacts would be less than significant.

Adaptive Implementation

Similar to LSJR Alternative 3 with adaptive implementation methods 1, 2, 3, and 4, LSJR Alternative 4 with adaptive implementation may result in some modifications at the local level to wetland assemblages. However, in the long term, plant communities may shift in elevation or species composition to accommodate changes in river flows. Consequently, the impact determination of LSJR Alternative 4 with adaptive implementation would be the same as described above for LSJR Alternative 4 without adaptive implementation. Impacts would be less than significant.

Impact BIO-3: Facilitate a substantial increase in distribution and abundance of invasive plants or nonnative wildlife that would have a substantial adverse effect on native terrestrial species

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

There are currently nonnative plant species present in the area of potential effects along the rivers and at the reservoirs, as well as in the area of potential indirect effects (see Section 8.2.1, *LSJR and the Three Eastside Tributaries*, under the subsections *Potentially Affected Habitats*, and *Potentially Affected Vegetation*, for a description of the invasive plant species). Invasive species programs have been established to reduce and control the spread of these species, including invasive species management plans developed in compliance with FERC regulations, various regional invasive species plans, and goals established by local weed management areas (see Section 8.3, *Regulatory Background*, for a description of the relevant invasive species plans and regulations).

LSJR Alternatives 2, 3, and 4 (Less than significant/Less than significant with adaptive implementation)

Invasive plants and animals already exist throughout the area of potential effects. It is acknowledged that baseline flow regimes both harm native plants and encourage nonnative species because flows and habitats are often mismatched (e.g., riparian habitats that need more variable flows do not receive them) (Moyle et al. 2010; CDFW 2014a). However, there is insufficient evidence to conclude that the baseline flow regime is the definitive factor in the establishment and spread of invasive species. It is likely that other habitat modifications, such as wetland reclamation and agricultural cultivation, are very important factors in the spread of invasive species. The LSJR alternatives would create a more variable flow regime in which flows vary by season to more closely mimic the natural hydrograph. This is expected to favor native species that have evolved life history characteristics that respond to seasonal flow patterns (Moyle and Bennett 2008; CDFW 2014a). However, more variable flow regimes constitute an ecosystem perturbation, and habitat disturbance can encourage the establishment and spread of invasive species (Davis and Thompson 2000). In light of these factors, the modifications in flow regimes under the LSJR alternatives are not anticipated to change the relative abundance of native and nonnative terrestrial species. Although modifying flows in the system may foster the development of expanded riparian zones, the diversity and richness of these habitats would generally follow baseline conditions. Compositional shifts may occur locally, but the relative abundance of these species at the ecosystem level would be consistent with baseline conditions. Likewise, the use of these habitats by nonnative wildlife species would continue and the relative abundance of these species is expected to be unchanged. While the LSJR alternatives (including the various adaptive implementation methods) may result in some alteration of vegetation patterns at specific locations, there is no information available to suggest that modified flows would substantially alter or facilitate the establishment of invasive plant or animal species. Furthermore, native species are more ecologically adapted to more natural flows (Moyle and Bennett 2008; CDFW 2014a; Moyle et al. 2010). There are also not expected to be increases in abundance or distribution of nonnative plants or wildlife species in the area of potential effects around the reservoirs since there are not likely to be large changes in water surface fluctuation compared to baseline conditions (Tables 8-7a, 8-7b, and 8-7c). Therefore, it is anticipated that impacts would be less than significant.

Area of Potential Indirect Effects

Decreased surface water diversions associated with LSJR Alternative 2 has the potential to result in decreased surface water available for agricultural irrigation in the plan area. Existing agricultural lands that do not receive irrigation water may not necessarily be fallowed in perpetuity or potentially converted to non-agricultural uses. Some agricultural activities on existing agricultural land would continue to occur in the form of dryland farming, rotational farming, or deficit irrigation depending on the type of crop affected, market conditions, and the individual decisions of farmers. These activities would help limit the distribution and abundance of invasive plant and wildlife species. Additionally, the potential for invasive plants and nonnative wildlife species to increase due to reduction in irrigation water availability would not be expected to exceed existing levels because if land is fallowed agricultural activities could occur to maintain the land even during periods when no crops are being grown on a particular field. In the event that the LSJR alternatives result in permanent reversion of some currently irrigated agricultural lands within the area of potential indirect effects to upland habitats or unirrigated grazing lands, a mix of native and nonnative vegetation could be expected to become re-established in the area. Such plant growth, even if heavily weighted towards non-native species, may foster a return to, or at least tend towards, increases in habitat diversity. This can favor increased species abundance or species richness (Crooks 2002). In some instances, non-native plant species may be useful catalysts for ecosystem restoration (Ewel & Putz 2004). Swainson's hawk (*Buteo swainsoni*) nesting densities in Central California have been noted to be the highest in areas with either a mixture of native habitat and agriculture or a high diversity of irrigated crops (England et al 1995). Finally, the invasive species programs as described in Section 8.3, *Regulatory Background*, would continue to be implemented throughout the plan area to reduce and control invasive species. Therefore, impacts would be less than significant.

Impact BIO-4: Have a substantial adverse effect, either directly or through habitat modifications, on any terrestrial animal species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW or USFWS

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Numerous candidate, sensitive or special-status animal species (special-status species) are found within the area of potential effects (see Tables 8-4a and 8-6), including around Lake McClure, where a fully protected species, Limestone salamander, was found to be present. Western pond turtle were also observed around the shore of Lake McClure and New Don Pedro Reservoir. Many of these special-status animal species are dependent on riparian habitat. The baseline flows have constrained riparian vegetation by reducing the amount of wetted habitat; however, land use changes and levee development along rivers have also led to a reduction in riparian habitat (see Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*). The loss of riparian vegetation has been an important factor in the decline of the California yellow warbler, western yellow-billed cuckoo, Least Bell's Vireo, and little willow flycatcher (Riparian Habitat Joint Venture 2004). Within California's Central Valley, all of these species depend on riparian vegetation for cover, foraging, and breeding. Valley elderberry longhorn beetle depends on elderberry shrub, a riparian species. Two mammal species, San Joaquin woodrat and riparian brush rabbit, also require riparian vegetation. Therefore, declines in riparian vegetation have likely caused declines in populations of these special-status species (CDFW 2014a). The analysis considered whether the LSJR alternatives may cause some temporary habitat disturbances, especially within, and nearby, stream channels, which might adversely affect some special-status animals. The analysis also examined whether the LSJR alternatives would have beneficial effects on some special-status species, particularly to the extent that increased flows encourage additional riparian habitat establishment. Habitat modifications that benefit special-status terrestrial animal species would be consistent with the goals of ESA, CESA, and the USFWS Recovery Plan.

Candidate, sensitive, or special-status animal species (special-status species) are found within the area of potential indirect effects (see Tables 8-4b). The analysis considers whether a reduction in irrigation water supply to existing agricultural lands would indirectly result in land cover that could substantially adversely affect a special-status species.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Rivers

As discussed in Impact BIO-1, modeled monthly flows on the Stanislaus River are expected to be similar to baseline flows. Flows for the Tuolumne and Merced Rivers and the LSJR are expected to be similar to or greater than baseline flows, depending on the month. In addition, as described under Impact BIO-1, adaptive implementation could increase the volume of water in the rivers compared to what would occur under 20 percent unimpaired flow at those times of increased releases/flows. Increases in flow are expected to be largest during the riparian recruitment period (i.e., end of April–June). While established riparian species are adapted to periodic fluctuations in flow, there is potential for increased spring flows to help establish new vegetation. The viability of this habitat is key for the continued existence of many special-status species, and the loss of riparian vegetation has been an important factor in their decline. A discussion of potential impacts on special-status species that could reside in the area of potential effects is included below. Special-status species include: elderberry longhorn beetle, California red-legged frog, California tiger salamander, western spadefoot toad, giant garter snake, western pond turtle, special-status bird species, several bat species, riparian brush rabbit, and San Joaquin Valley woodrat. Overall, impacts on these special-status species on the Stanislaus, Tuolumne, and Merced Rivers and LSJR would be less than significant.

In the area of potential effects, elderberry shrubs typically are located on the higher portions of levees and streambanks within the levees and are generally not subject to regular inundation or scouring, although they can withstand periodic inundation (USBR 2010a). LSJR Alternative 2 is not likely to result in direct loss of elderberry shrubs or any resident beetles. LSJR Alternative 2 would generally increase the amount of water available to elderberry roots, which may stimulate growth of elderberry shrubs and ultimately have a beneficial effect on habitat for this species on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Impacts would be less than significant.

The area of potential effects contains suitable habitat for California red-legged frogs, California tiger salamanders, and western spadefoot toads. However, there are no known populations in close proximity to the channels affected by LSJR Alternative 2 (CDFG 2012). The best aquatic habitats for amphibian and reptile use are the backwaters and ponds that are not influenced greatly by rising and falling flows. In addition, any amphibian and reptile use of the channels in the LSJR area of potential effects would already be subject to rising and falling flows, and such populations would be adapted to this variable habitat. Thus, LSJR alternatives would not have a significant adverse effect on the primary habitat elements for special-status amphibians. Impacts would be less than significant.

Special-status aquatic reptiles, including giant garter snake and western pond turtle, may occur in the portions of the river channel that would be inundated by the LSJR Alternative 2. These species require aquatic habitat for breeding and foraging during spring and summer. Additional flows during these seasons, as well as in winter, would have a beneficial effect on these species. Although water velocities would increase in certain areas, it is expected that velocity would not be substantially altered from historical flow regimes. Impacts on upland habitats that these species use for refuge are not expected under the LSJR alternatives because flows generally would be restricted to the river channel. Impacts would be less than significant.

Many special-status birds build nests in large trees or shrubs that would be elevated above the areas affected by LSJR Alternative 2. Some special-status species nest closer to the ground in emergent in-stream or on-terrace marsh vegetation that could be present in portions of the river channel. Non-flood flows during the breeding season (typically February–September) are expected to increase on the Tuolumne and Merced Rivers and the LSJR under LSJR Alternative 2, and there would be a potential for increased flows to inundate nest sites of ground nesters. However, these areas already are subject to regular or periodic inundation from seasonal flood flows, the breeding populations are adapted to this variable environment, and the aggregate of the individual breeding periods for the different species results in a relatively large window of breeding time. As the flow alters the channels of the rivers, ground nesters would move with the establishment of emergent vegetation that they use as nesting habitat. Impacts would be less than significant.

Various special-status mammal species occur in the area of potential effects, including several bat species, riparian brush rabbit, and San Joaquin Valley woodrat. Changes in flows associated with LSJR Alternative 2 would be largely confined to existing channels and are not expected to affect upland breeding and foraging sites required by these mammals. Impacts would be less than significant.

Reservoirs

Special-status species found to occur in the area of potential effects around the reservoirs include Limestone salamander, which has been documented to occur at Lake McClure, and western pond turtle, which were observed within the zone of fluctuation around New Don Pedro Reservoir (TID and MID 2013a). Implementation of LSJR Alternative 2 is not expected to negatively impact special-status species around the reservoirs since the resulting water surface elevation fluctuations are not expected to be very different from the baseline conditions (Tables 8-7a, 8-7b, and 8-7c). Western pond turtles typically select nesting sites with at least some vegetation (low grasses and forbs), therefore these sites would not be impacted by frequent inundation and would therefore not be negatively impacted by implementation of LSJR Alternative 2.

Southern Delta

Modeled results indicate that EC values in the southern Delta could increase or decrease depending on which LSJR alternative is implemented (Tables 5-25 and Tables 5-26a, 5-26b, and 5-26c), but overall salinity in the southern Delta would be slightly reduced (Tables 5-29a, 5-29b, and 5-29c) under LSJR Alternative 2. These changes would be very small, if imperceptible. According to Impact BIO-1, LSJR Alternative 2 is not expected to impact the overall quantity or quality of the habitats in the southern Delta. Since habitats are not expected to be affected, the special-status species are not expected to be affected. Impacts would be less than significant.

Adaptive Implementation

Adaptive implementation of method 1 would allow an increase of up to 10 percent over the 20-percent minimum February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. Adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June timeframe. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June minimum flow requirement. WSE results show that changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR.

If method 1 is implemented, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20 percent unimpaired flow, depending upon flow conditions and frequency of the adjustment, and more similar to those described under LSJR Alternative 3. Generally increased flows are expected to be largest during the riparian recruitment period (i.e., end of April–June). While established riparian species are adapted to periodic fluctuations in flow, there is potential for increased spring flows to help establish new vegetation. The viability of this habitat is key for the continued existence of many special-status species, and the loss of riparian vegetation has been an important factor in their decline. It is anticipated that an increase in flow would not result in a loss of riparian habitat. If method 2 is implemented, the total annual volume of water associated with LJSR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change. As a result, the total volume of water that would remain in the river would not change with adaptive implementation method 2, and impacts associated with total volume of water would not change. Resources that are dependent on the timing or magnitude of flow could potentially be affected by method 2. Riparian resource recruitment in stream channels is somewhat dependent on the timing or magnitude of flow; however these resources are adapted to natural flood and drought cycles. Higher flows under adaptive implementation method 1 would not exceed the higher range of flows that could be experienced under baseline for some water years. However, given that this method would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described above for LSJR Alternative 2 without adaptive implementation. Impacts would be less than significant.

Area of Potential Indirect Effects

Decreased surface water diversions associated with LSJR Alternative 2 with adaptive implementation has the potential to result in decreased surface water available for agricultural irrigation in the plan area. Existing agricultural lands that do not receive irrigation water may not necessarily be fallowed in perpetuity or potentially converted to non-agricultural uses. Other less intensive uses, such as dryland farming, deficit irrigation (i.e., reduction in irrigation), and grazing could take place on lands that experience a reduction in irrigation water. For example, some crops (e.g., alfalfa and pasture) are able to survive under deficit irrigation where only a portion of the crop water demands are met (Putnam et al. 2015a, 2015b). If the full water requirements were continually restricted, they could still potentially remain in agricultural use (Putnam et al. 2015a, 2015b). Furthermore, a reduction of irrigation water supply would not reduce the amount of other habitat within the plan area suitable for sensitive species, including riparian corridors, rangeland, and native and introduced trees.

While agricultural lands can be an important tool for species conservation, their value is usually derived from comparing habitat function to urban or industrial land use types. Therefore, it is expected that potential removal or reduction of active agriculture on lands which remain in a fallowed or other undeveloped or open space use would not result in a significant adverse effect on special-status and sensitive species. Moreover, a reduction of active agricultural management, soil tilling, crop harvesting, and herbicide and pesticide application, primarily in the plan area, would potentially benefit special-status species by reducing disturbance to potentially suitable habitat and by reducing overall population and habitat fragmentation. Special-status species within the plan area, such as California tiger salamander (*Ambystoma californiense*), San Joaquin kit fox (*Vulpes macrotis mutica*), Swainson's hawk (*Buteo swainsoni*), and various other California native wildlife populations declined as a result of the conversion California's annual grasslands to agricultural lands (CDFG 2000; Estep 1989; Loredo et al. 1996; Wheeler 2003; CDFW n.d.). Several Central Valley species identified in the USFW Recovery Plan (USFWS 1998) that occur in the San Joaquin Valley and in intermittent areas of the plan area, including the kit fox (noted as a keystone species for the Valley) and the blunt nosed leopard lizard (*Gambelia sila*), are particularly susceptible to active agricultural activities. Active agricultural activities have been identified as being detrimental to their habitat and survival (USFWS 1998). In particular, the principal factors in the decline of the San Joaquin kit fox were loss, degradation, and fragmentation of habitats associated with agricultural, industrial, and urban developments in the San Joaquin Valley. The conservation strategy for San Joaquin kit fox has been identified as strategically retiring agricultural lands that have serious drainage problems to reduce the effects of widespread habitat fragmentation of populations (USFWS 1998). Similarly, effects on the blunt nosed leopard lizards have been attributed to active agriculture as more than 95 percent of the original natural communities have been destroyed and collectively have caused the reduction and fragmentation of populations and decline of this species (USFWS 1998).

Lands that receive less irrigation water could prove valuable in providing habitat connectivity and reducing fragmentation for special-status and sensitive species, depending on the location of the land and the acreage. The special-status terrestrial wildlife habitat value for idle fields or pasture lands is typically higher than that of active agricultural fields due to the lack of seasonal anthropogenic disturbances and a reduction of the overall vegetative uniformity (USFWS 2009; USFWS 2010c; CDFW 2014b; Woodbridge 1991). For example, there is limited habitat functionality of orchard trees for nesting or roosting under active agricultural management. The existing limited habitat value would be exceeded by eventual establishment of native or suitably adapted introduced vegetation. This vegetation would not be subjected to the regular pruning, harvesting, and other disturbance activities typically associated with orchard trees, thereby providing more secure nesting opportunities. Similarly, native grass and shrub communities would provide greater foraging habitat value than intensively managed crops experiencing regular and periodic disturbance (e.g., plowing, mowing) and rodent control. All of these active agriculture activities reduce the available prey base for raptors. Populations of California tiger salamander, found in the San Joaquin Valley and in the plan area, would also benefit from the development of rodent communities in undisturbed land. Rodent holes are suitable habitat for the California tiger salamander and a reduction of heavily controlled rodent activities on active agricultural lands would result in a potential increase in habitat for this species. As such, the potential reduction of irrigation water to agricultural lands under LSJR Alternative 2 with adaptive implementation, with the resultant halting of mechanized agriculture, pesticide and rodenticide application, and anthropogenic disturbance is unlikely to result in a substantial adverse effect on sensitive or special-status species. Further, the potential reduction of monocultural irrigated crops is likely to support the species and ecosystem recovery strategy outlined in the USFWS recovery strategy. As such, it is not expected that a reduction in irrigation water supply would result in a substantial adverse indirect effects through habitat modification on special-status species. Impacts would be less than significant.

LSJR Alternatives 3 and 4 (Less than significant/Less than significant with adaptive implementation)

Rivers

Overall, median monthly flows would be higher on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR under LSJR Alternatives 3 and 4. In some limited instances, LSJR Alternatives 3 and 4 would result in a reduction in flow, primarily during the wettest years, as a result of a reduced need for flood control releases. The overall volume of water February–June would be greater when compared to baseline conditions (Table 5-16) under the specified unimpaired flow requirements (i.e., 40 percent and 60 percent) and under the adaptive implementation methods 1, 2, and 3. Impacts on riparian habitat would be less than significant. Thus, the changes in riparian habitat are not anticipated to affect special-status animal species dependent upon riparian habitat, as described under the discussion for LSJR Alternative 2. Therefore, it is anticipated that impacts on special-status species as a result of LSJR Alternatives 3 and 4 would be less than significant.

Reservoirs

Special-status species found to occur in the area of potential effects around the reservoirs include Limestone salamander and western pond turtle. Results from the limestone salamander survey conducted around Lake McClure (Merced ID 2011b) indicate that while high water elevations occasionally inundate suitable habitat for limestone salamanders, these inundations rarely occur during periods when the salamanders are above ground. During rare periods when high water levels coincide with above-ground activity, it is likely that salamanders would be able to relocate upslope to avoid submersion. Western pond turtles typically select nesting sites with at least some vegetation (low grasses and forbs), therefore these sites would not likely be impacted by inundation due to water level fluctuation at the reservoirs. Implementation of LSJR Alternatives 3 and 4 is not expected to negatively impact special-status species around the reservoirs since the resulting water surface elevation fluctuations would not be very different from the baseline conditions (Tables 8-7a, 8-7b, and 8-7c).

Southern Delta

Modeled results indicate violations of the EC objectives in the southern Delta would decrease (Table 5-25 and Tables 5-27a, 5-27b, and 5-27c), and overall salinity in the southern Delta would be reduced (Tables 5-29a, 5-29b, and 5-29c) under LSJR Alternatives 3 and 4. These changes would be very small, if imperceptible. According to Impact BIO-1, LSJR Alternatives 3 and 4 are not expected to impact the overall quantity or quality of the habitats in the southern Delta. Since habitats are not expected to be affected, the special-status species are not expected to be affected. Impacts would be less than significant.

Area of Potential Indirect Effects

Decreased surface water diversions associated with LSJR Alternatives 3 or 4 with or without adaptive implementation have the potential to result in decreased surface water available for agricultural irrigation in the plan area. As discussed above under LSJR Alternative 2, with adaptive implementation, existing agricultural lands that do not receive irrigation water may not necessarily be fallowed in perpetuity or potentially converted to non-agricultural uses. Other less intensive uses such as dryland farming, deficit irrigation (i.e., reduction in irrigation), and grazing, could take place on lands that experience a reduction in irrigation water. For example, some crops (e.g., alfalfa and pasture) are able to survive under deficit irrigation where only a portion of the crop water demands are met (Putnam et al. 2015a, 2015b). If the full water requirements were continually restricted, they could still potentially remain in agricultural use (Putnam et al. 2015a, 2015b). Furthermore, a reduction in irrigation water supply would not reduce the amount of other habitat within the plan area suitable for sensitive species, including riparian corridors, rangeland, and native and introduced trees.

Similar to the discussion above for LSJR Alternative 2 with adaptive implementation, agricultural lands can be an important tool for species conservation, their value is usually derived from comparing habitat function to urban or industrial land use types. Therefore, it is expected that potential removal of active agriculture on lands which remain in a fallowed or other undeveloped use or open space uses would not result in a significant adverse effect on special-status and sensitive species. Moreover, a reduction of active agricultural management, soil tilling, crop harvesting, and herbicide and pesticide application, would potentially benefit special-status species by reducing disturbance to potentially suitable habitat and by reducing overall population and habitat fragmentation(CDFG 2000; Estep 1989; Loredo et al. 1996; Wheeler 2003; CDFW n.d.). Active agricultural activities have been identified as being detrimental to the habitat and survival of several special-status species, including the San Joaquin kit fox (*Vulpes macrotis mutica*) and blunt nosed leopard lizard (*Gambelia sila*) (USFWS 1998).

Lands that receive less irrigation water could prove valuable in providing habitat connectivity and reducing fragmentation for special-status and sensitive species, depending on the location of the land and the acreage. The special-status terrestrial wildlife habitat value for idle fields or pasture lands is typically higher than that of active agricultural fields due to the lack of seasonal anthropogenic disturbances and a reduction of the overall vegetative uniformity (USFWS 2009; USFWS 2010c; CDFW 2014b; Woodbridge 1991).

As such, the potential reduction of irrigation water to agricultural lands under the flow requirements, with the resultant halting of mechanized agriculture, pesticide and rodenticide application, and anthropogenic disturbance is unlikely to result in a substantial adverse effect on sensitive or special-status species. Further, the potential reduction of monocultural irrigated crops is likely to support the species and ecosystem recovery strategy outlined in the USFWS recovery strategy. As such, potential impacts on sensitive or special-status species as a result of a reduction in irrigation water under LSJR Alternatives 3 or 4 with or without adaptive implementation would be less than significant.

Impact BIO-5: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan or conflict with any local policies or ordinances protecting biological resources

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

An activity could conflict with a conservation plan, such as the SJR Wildlife Refuge CCP and the San Joaquin County Multi-Species HCP, management plans of existing national wildlife refuges or other wildlife areas, natural community conservation plants, or local policies or ordinances, if it would substantially reduce the effectiveness of the plan's conservation strategies or otherwise prevent attainment of the plan's goals and objectives. Conflicts can result from reducing the viability of populations that are targets of the plan's goals, objectives, and conservation strategies. Also, other actions can conflict with implementing conservation plans and reduce the habitat value of conserved lands (e.g., by creating adjacent, incompatible land uses), interfere with the management of conserved lands (e.g., by eliminating access or water supplies), or eliminate opportunities for conservation activities (e.g., by developing land identified for preservation in the plan).

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

LSJR Alternative 2 would not create adjacent incompatible land uses, develop land, or otherwise result in actions incompatible with conservation plans or activities as this alternative does not require or result in those types of activities. As described in Impact BIO-1 through Impact BIO-4, it is expected flows under LSJR Alternative 2 with adaptive implementation would have an overall cumulative distribution (i.e., the range of flows distributed between the minimum flow [thousand acre-feet] and the maximum flow over the entire 82-year historic modeling period) similar to baseline conditions on the Stanislaus River. The median monthly flows would generally be very similar to or greater than baseline flows on the Tuolumne and Merced Rivers and the LSJR under LSJR Alternative 2 with adaptive implementation. Furthermore, the overall volume of water described by the cumulative distribution of flows February–June would be slightly greater than baseline, with adaptive implementation. Similarly, implementation of LSJR Alternative 2 with adaptive implementation is not expected to lead to significant changes in water level fluctuation around the reservoirs and would not be incompatible with habitat conservation plans or activities at those locations. As such, the river flows and reservoir elevations are not expected to reduce the viability of populations that are targets of the various plan goals.

LSJR Alternative 2 could adjust existing water supply diversions; however, the average annual adjustment could be a reduction of approximately 3 percent in the entire plan area and vary between 2 and 6 percent in each of the tributaries (Table 5-19). This is within the general variability of surface water supply diversions provided from the three eastside tributaries and the LSJR (Table 5-20). As such, adjustments to water supply diversions are not expected to reduce the viability of populations that are targets of various plan goals.

LSJR Alternative 2 with adaptive implementation, is not expected to reduce the viability of populations that are targets of the various plan goals. Therefore, conflicts with an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan would not occur. Impacts would be less than significant.

LSJR Alternatives 3 and 4 (Less than significant/Less than significant with adaptive implementation)

LSJR Alternatives 3 and 4 would not create adjacent incompatible land uses, develop land, or otherwise result in actions incompatible with conservation plans or activities as these two alternatives do not require or result in those types of activities.

As described in Impact BIO-1 through Impact BIO-4, it is expected that flows under LSJR Alternatives 3 and 4 with or without adaptive implementation, would generally result in higher monthly flows on the three eastside tributaries and the LSJR. The expected increases in flows and the limited instances in which there would be a reduction in flows, would generally benefit biological species. Similarly, implementation of LSJR Alternatives 3 and 4 with adaptive implementation is not expected to lead to significant changes in water level fluctuation around the reservoirs and would not be incompatible with habitat conservation plans or activities. As such, the river flows and reservoir elevations are not expected to reduce the viability of populations that are targets of the various plan goals.

As discussed in Table 8-2, there are national wildlife refuges and other wildlife areas that receive water from the three eastside tributaries and the LSJR. Some of these have management plans and some do not. The wildlife areas that do not have management plans (Stanley Wakefield Wilderness Area, West Hilmar Wildlife Area, and Calaveras River Wildlife Area) rely on surface water supplies from flows of the rivers they are adjacent. Under LSJR Alternatives 3 and 4 with adaptive implementation these areas would typically experience higher flows when compared to baseline conditions. As such, it's expected that these areas would not experience elimination or reduced water supplies. Although these areas do not have management plans, given the flows in the rivers, and the discussion under Impacts BIO-1 through BIO-4, biological species would not be affected. The following wildlife refuges and areas have management plans or CCPs: North Grasslands Wildlife Area; SJR National Wildlife Refuge; Merced National Wildlife Refuge; and San Luis National Wildlife Refuge (Table 8-1 and Section 8.3, *Regulatory Background*). These refuges and areas rely on surface water supplies from the rivers through different mechanisms, including: appropriative rights; riparian rights; and contracts, as described in their water management plans (Table 8-1). Groundwater supplies augment surface water supplies, or provide water supply, for those areas that have groundwater wells (Table 8-1).

As described in Tables 5-19 and 5-20, water supply diversions may be reduced under LSJR Alternatives 3 and 4. This outcome has the potential to affect the sources of water for the wildlife areas. However, groundwater wells would continue to be used on all wildlife areas under the LSJR alternatives to provide water and augment water supply when needed, as they are currently under baseline conditions. In addition, existing policies and procedures in place on pooling, transfers, reallocations, and exchanges would be followed to ensure adequate water supply. These existing policies and procedures are established either within the management plans or in the CVPIA, or in water supply contracts. Furthermore, the wildlife areas have prioritized the habitat cover types that receive water during different year water types, depending on the availability of water, and this would continue under LSJR Alternatives 3 and 4. For example, under baseline conditions L4 (see Table 8-2) water is frequently not delivered to some wildlife areas, and the areas follow their plans and policies with respect to prioritization of the habitat cover types that receive water. Given the management of the different areas' water supplies, it is anticipated that adjustments to water supply under LSJR Alternatives 3 and 4 would not be expected to reduce the viability of populations that are targets of various plan goals.

LSJR Alternatives 3 and 4 with adaptive implementation are not expected to reduce the viability of populations that are targets of the various plan goals. Therefore, conflicts with an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan would not occur. Impacts would be less than significant.

8.4.4 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows, as described in Chapter 5, *Surface Hydrology and Water Quality,* in the extended plan area could potentially impact terrestrial biological resources in upstream reservoirs on the Stanislaus and Tuolumne Rivers differently in the extended plan area than described for the plan area. The reservoirs on the Stanislaus and Tuolumne Rivers may experience substantial changes in reservoir volume, especially under drought conditions under LSJR Alternatives 3 and 4, which are not experienced by the rim reservoirs in the plan area. This different potential impact occurs because these reservoirs are smaller than the downstream rim reservoirs, which could magnify individual changes. Reservoir drawdown would reduce the area and volume of water available for foraging, hunting, and fishing by avian and mammal species (e.g., shore birds, ducks, hawks, and bears). Reservoir drawdown could also remove the hydrologic connection of shoreline wetlands from the reservoir water. If this occurred, it would cause them to dry out during the drawdown period and could affect species reliant on these habitats. Amphibians dependent on wetlands or reservoir-associated aquatic habitat could also be affected. The extent and severity of the effect to mobile species would be reduced by their ability to move and use another reservoir or nearby aquatic resources. Sensitive plant species and wetland habitat that occur within the high water mark of the reservoirs may be affected the most. However, sensitive plant species in these reservoir fringe communities already experience desiccation during baseline reservoir drawdown and the impacts on them would not be substantially increased. Amphibian species in these fringe communities could be affected the most but some could also move to adjacent aquatic habitats such as inflowing streams and rivers.

Under LSJR Alternative 2 and under LSJR Alternative 3 in most years, the type and scale of impacts on these species and wetlands during individual reservoir drawdown events would be similar to what is experienced during baseline reservoir operations (USGS Reservoir Gage Data). Additionally, these reservoirs would refill during the subsequent wet season, limiting the duration of reduced reservoir elevation levels. In the most extreme cases, during drought years and years with substantial increases in bypasses in the extended plan area under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation, some reservoirs might be drawn more quickly, to lower levels, and for longer periods than under baseline conditions. If these conditions occurred, there would be adverse impacts on terrestrial species, primarily plant species and wetland habitats, because the reservoir habitat would be greatly reduced when compared to baseline conditions. Under these conditions, impacts on wetlands and wetland-associated species would be substantially longer than under baseline conditions.

The riparian habitat is limited along the steep bedrock banks of the rivers in the extended plan area. An increase in flow is not expected to impact terrestrial biological species (similar to the plan area). However, flows in the extended plan area could decrease in the fall relative to baseline under the LSJR alternatives, which is not anticipated to occur in the plan area. This could result in the potential for reduced habitat conditions for terrestrial species.

The increased frequency of lower reservoir levels and potential reduction in river flow in the fall resulting from the LSJR alternatives, however, would be limited by the program of implementation under each of the LSJR alternatives. The program of implementation requires minimum reservoir carryover storage targets or other requirements to help ensure that providing flows to meet the flow objectives will not have adverse temperature or other impacts on fish and wildlife. Other requirements, for example, include, but are not limited to, limits on required bypass flows for reservoirs that store water only for non-consumptive use so that some water can be temporarily stored upstream. The program of implementation also states that the State Water Board will take actions as necessary to ensure that implementation of the flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods. Accordingly, when the State Water Board implements the flow objectives in a water right proceeding, it will consider impacts on fish, wildlife, and other beneficial uses and health and safety needs, along with water right priority. Until the State Water Board assigns responsibility to meet the flow objectives in the Bay-Delta Plan, it is speculative to identify the exact extent, scope, and frequency of reduced diversions, reduced reservoir levels and their effects on wildlife and plant species, in the extended plan area. When implementing the flow objectives, the State Water Board would identify project-specific impacts and avoid or mitigate significant impacts of lower reservoir levels on wildlife species and habitat in accordance with CEQA.

At the time of preparation of this programmatic analysis, it is unclear to what extent any significant impacts could be fully mitigated to wildlife, wetland and other sensitive plant species. Thus, the potential exists for significant impacts. Therefore, this analysis conservatively concludes that impacts associated with lower reservoir levels under LSJR Alternatives 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation are significant. The following mitigation measure is proposed: when considering carryover storage and other requirements to implement the flow water quality objectives in a water right proceeding, the State Water Board shall ensure that reservoir levels upstream of the rim dams do not cause significant wildlife impacts, unless doing so would be inconsistent with applicable laws. The impact is considered significant, even with mitigation, because the mitigation may not fully mitigate the impact in all situations.

8.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 9
Groundwater Resources

9.1 Introduction

This chapter describes the environmental setting for groundwater resources, including the physical characteristics of the four groundwater subbasins (Eastern San Joaquin, Modesto, Turlock, and Extended Merced[1]) that underlie the surface water delivery areas from the three eastside tributaries.[2] It discusses the regulatory background associated with protecting groundwater resources and groundwater management and evaluates the potential environmental impacts on the groundwater basins, as a resource, which could result from the Lower San Joaquin River (LSJR) alternatives, if applicable, it also offers mitigation measures that would reduce significant impacts.

This chapter analyzes increased groundwater pumping, reduced groundwater recharge from surface water percolation, and related effects (e.g., subsidence) that may occur as a result of the effect of the LSJR alternatives on surface water supplies to the irrigation district service areas. This chapter discusses those potential groundwater supply and groundwater recharge effects under current regulatory conditions. Those current regulatory conditions include the Sustainable Groundwater Management Act (SGMA) (Wat. Code, § 10720 et seq.), which took effect January 1, 2015, and requires the formation of local agencies to protect and manage groundwater resources. SGMA is discussed in more detail below. Southern Delta water quality (SDWQ) alternatives are not discussed in this chapter because the SDWQ alternatives would not result in a change in groundwater pumping or groundwater recharge from surface water that currently takes place in the plan area. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on groundwater resources. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

As stated above, this chapter analyzes the groundwater basins in the study area as a resource. For a discussion of potential effects to agricultural lands from the LSJR and SDWQ alternatives, see Chapter 11, *Agricultural Resources*. Irrigation districts in the study area provide some municipal water supplies; this topic is discussed briefly in Section 9.2, *Environmental Setting*. However, multiple communities and water purveyors in the study area either do not have water supply contracts with the irrigation districts or are located outside the irrigation district service areas. Therefore, the potential impacts on municipal water suppliers and domestic wells from LSJR and SDWQ alternatives are addressed in Chapter 13, *Service Providers*.

As described in Chapter 2, *Water Resources,* the plan area overlay seven of the subbasins in the San Joaquin Groundwater Basin (Figure 2-3). The study area for groundwater, as defined in this chapter, includes the four main groundwater subbasins (the Eastern San Joaquin, Modesto, Turlock, and Merced) plus a small area of the Chowchilla Subbasin that is between the Merced Subbasin and the

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[1] The *Extended Merced Basin* is used to reference the Merced Basin and a portion of the Chowchilla Basin, as defined in the body of the text above.

[2] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

Chowchilla River; this area is part of the surface water delivery area for the Merced River (Figure 9-1). The Merced Subbasin, with this added area, is referenced as the *Extended Merced Subbasin*. The study area represents the primary area that could potentially experience groundwater effects associated with the LSJR alternatives. The remaining portion of the Chowchilla Subbasin south of the Chowchilla River, the Tracy Subbasin, and the Delta-Mendota Subbasin, are not part of the study area because they are not part of the surface water delivery area for the three eastside tributaries.

The extended plan area, also described in Chapter 1, *Introduction*, generally includes the area upstream of the rim dams.[3] Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified. In addition to the seven subbasins in the plan area, the extended plan area also includes the Yosemite Valley Basin.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Resources Control Board (State Water Board) determined whether the plan amendments[4] would cause any adverse impact for each environmental category in the checklist and provided a brief explanation for its determination. The Appendix B checklist identified LSJR alternatives as having a "Potentially Significant Impact" on groundwater resources as identified in Section IX(b) and VI(c). Accordingly, this chapter evaluates the potential impacts of the LSJR alternatives on groundwater resources and whether the alternatives would substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a significant net deficit in aquifer volume or a significant lowering of the local groundwater table level. It also evaluates whether the potential impacts of the LSJR alternatives would result in subsidence. The potential impacts associated with groundwater resources and the LSJR alternatives are summarized in Table 9-1.

The impacts of the LSJR alternatives on groundwater elevations, aquifer storage, and risk of subsidence cannot be determined with certainty because groundwater conditions vary within each aquifer subbasin and water users would have varied responses to reduced surface water deliveries. In addition, SGMA, mentioned above, will impact groundwater management as it places a mandatory duty upon local agencies in high- and medium-priority groundwater basins to form groundwater sustainability agencies (GSAs) by June 30, 2017, in order to adopt and implement groundwater sustainability plans (GSPs) to sustainably manage groundwater resources.[5] Upon GSP adoption, SGMA grants a local GSA specific authorities to manage and protect its groundwater basin including, but not limited to, the ability to require reporting of groundwater withdrawals and to control groundwater extractions by regulating, limiting, or suspending extractions from wells. (Wat. Code, § 10726.4.) If a local agency is unwilling or unable to manage its groundwater resources to prevent undesirable results including, but not limited to, chronic lowering of groundwater levels, significant and unreasonable reductions in groundwater storage, and significant and unreasonable degraded water quality, then SGMA empowers the State to provide interim management until local agencies are able to assume management. SGMA is discussed in more detail in Section 9.3, *Regulatory Background.*

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[3] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

[4] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

[5] The Modesto and Turlock Subbasins are listed as high-priority basins and the Eastern San Joaquin, Merced, and Chowchilla Subbasins are listed as high-priority and critically overdrafted basins. For critically overdrafted basins subject to SGMA, plans must be adopted by January 31, 2020. For all other basins subject to SGMA, the deadline is January 31, 2022. See the Sustainable Groundwater Management Act discussion in Section 9.3.2, *State [Regulatory Background].*

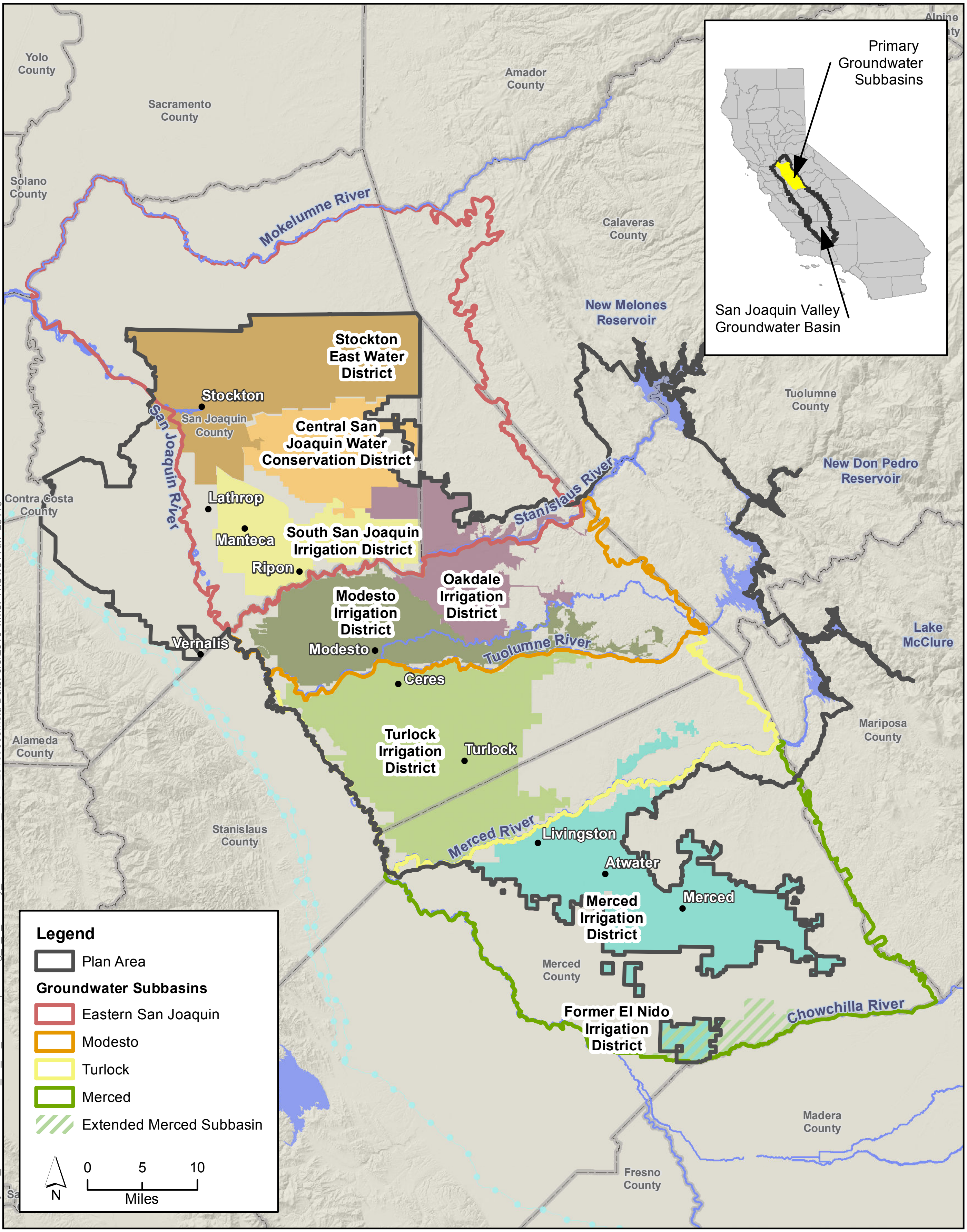

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Figure 9-1
Vicinity Map of Groundwater Subbasins

However, since the groundwater protections that will be afforded by SGMA cannot be determined at this time with precision, this chapter evaluates the potential impacts on groundwater levels from LSJR alternatives without including SGMA as an ameliorating factor, which means that estimates of impacts are likely more conservative (i.e., worse) than would occur in the groundwater basins over time. Potential impacts from LSJR alternatives were evaluated by estimating increased levels of pumping to replace reduced surface water supplies and estimating reduced deep percolation of surface water in response to decreased conveyance and application of surface water. This analysis assumes that an average annual reduction in the groundwater balance for a subbasin caused by increased groundwater pumping and reduced recharge from surface water equivalent to 1 inch or more of water across the subbasin could be potentially significant: it could result in long-term groundwater resource impacts, including groundwater overdraft (i.e., pumping more than recharge over the long term), and reduced water levels at existing wells.

The impact analysis for this chapter uses results from the State Water Board's Water Supply Effects (WSE) model to determine if the LSJR alternatives would result in impacts on groundwater resources by increasing groundwater pumping and reducing groundwater recharge relative to the baseline water balance for each of the four subbasins in the study area. The WSE model estimates the various levels of demand and surface water diversions for each LSJR alternative. If crop needs are not fully satisfied by minimum groundwater pumping and surface water diversions, additional groundwater pumping is added based on the capacity of the groundwater pumping and distribution infrastructure. Because baseline is representative of 2009 infrastructure, the primary groundwater analysis utilizes estimates of maximum groundwater pumping that were possible in 2009. However, recent drought conditions have resulted in more wells being drilled. Therefore, estimates of maximum groundwater pumping for 2014 were also assessed. A detailed description of the groundwater analysis methods and results is provided in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*. A summary of the Appendix G analysis relevant to this chapter is provided in Section 9.4, *Impact Analysis.*

Impacts related to the No Project Alternative (LSJR/SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to actions and methods of compliance.

Table 9-1. Summary of Groundwater Resources Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact GW-1: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA
LSJR Alternative 2	The average annual groundwater balance is expected to be reduced by less than the equivalent of 1 inch across each of the subbasins. This is not expected to produce a measurable decrease in groundwater elevations. Therefore, there would not be a substantial depletion of groundwater supplies or substantial interference with groundwater recharge. However, if adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%), the average annual groundwater balance could potentially be reduced by the equivalent of more than 1 inch across the Extended Merced Subbasin. If this occurred, it would eventually produce a measurable decrease in groundwater elevations. Therefore, there could be a potentially significant and unavoidable depletion of groundwater supplies or interference with groundwater recharge, and resulting potential migration of groundwater contamination in this subbasin under LSJR Alternative 2 with adaptive implementation.	Less than significant	Significant and unavoidable[c]
LSJR Alternative 3	The average annual groundwater balance could potentially be reduced by more than the equivalent of 1 inch in three subbasins (Modesto, Turlock, and Extended Merced). If this occurred, it would eventually produce a measurable decrease in groundwater elevations. The effect would be more severe during dry years and in areas farther from the SJR, the valley low point towards which groundwater slowly moves. Therefore, there could be a potentially significant and unavoidable depletion of groundwater supplies or substantial interference with groundwater recharge, and resulting potential migration of groundwater contamination under this alternative.	Significant and unavoidable	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternative 4	The average annual groundwater balance could potentially be reduced by more than the equivalent of 1 inch in all four subbasins. If this occurred, it would eventually produce a measurable decrease in groundwater elevations. The effect would be more severe during dry years and in areas farther from the SJR, the valley low point toward which groundwater slowly moves. Therefore, there could be a potentially significant and unavoidable depletion of groundwater supplies or interference with groundwater recharge, and resulting potential migration of groundwater contamination under this alternative.	Significant and unavoidable	Significant and unavoidable
Impact GW-2: Cause subsidence as a result of groundwater depletion			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA
LSJR Alternative 2	The average annual groundwater balance is expected to be reduced by less than the equivalent of 1 inch across each of the subbasins. This is not expected to produce a measurable decrease in groundwater elevations or associated subsidence. However, if adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%), the average annual groundwater balance could potentially be reduced by the equivalent of more than 1 inch across the Extended Merced Subbasin. If this occurred, it could worsen subsidence that is already occurring in this subbasin. Therefore, subsidence could potentially significantly increase under LSJR Alternative 2 with adaptive implementation.	Less than significant	Significant and unavoidable[c]

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternatives 3 and 4	The average annual groundwater balance could potentially be reduced by more than the equivalent of 1 inch across three subbasins (Modesto, Turlock, and Extended Merced) under LSJR Alternative 3 and across all four subbasins under LSJR Alternative 4. If this occurred, it could worsen subsidence that is already occurring in the Extended Merced Subbasin. Therefore, there could be a potentially significant and unavoidable increase in subsidence under LSJR Alternatives 3 and 4.	Significant and unavoidable	Significant and unavoidable

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 9.4.2, *Methods and Approach*.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives identified in the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan). See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

[c] Implementing adaptive implementation method 1 on a more frequent basis could result in a change in the impact determination for LSJR Alternative 2, as summarized in this table, and described in detail in Section 9.4.3*, Impacts and Mitigation Measures*.

9.2 Environmental Setting

This section describes the location, geology, aquifers, recharge and precipitation, groundwater quality, and groundwater use of the seven subbasins in the plan area, with a primary focus on the four subbasins in the study area. The boundaries of the seven subbasins underlying the plan area are described in Table 9-2.

9.2.1 San Joaquin Valley Groundwater Basin and Subbasins

The northern portion of the San Joaquin Valley Groundwater Basin, as defined in the California Department of Water Resources (DWR) Bulletin 118,[6] approximately coincides with the San Joaquin River (SJR) Hydrologic Region.

Although groundwater aquifers are connected between all the subbasins, rivers are generally used as the subbasin boundaries, with the SJR forming the western boundary, and the Mokelumne, Stanislaus, Tuolumne, and Merced Rivers forming the northern and southern boundaries of the four main subbasins underlying the plan area. The Merced-Madera County line and Chowchilla River are used for part of the southern boundary for the Merced Subbasin, but towards the west, the southern boundary is north of the county line and Chowchilla River and follows irrigation district boundaries. The eastern boundary for the four subbasins underlying the study area abuts the Sierra Nevada foothills. There are fewer wells along the eastern edge of the subbasins; the extent of the aquifers is largely unknown in areas without large municipal production wells as domestic wells are generally

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[6] DWR's Bulletin 118 series of reports summarize and evaluate California groundwater resources.

unreliable indicators. Aquifer characteristics of these subbasins (Table 9-3) are described in *California's Groundwater*, the 2003 update of the DWR Bulletin 118 (DWR 2003a).

Table 9-2. Groundwater Subbasins Underlying the Plan Area

Subbasin	Subbasin Boundaries	Total Subbasin Surface Area (thousands of acres)	Critically Overdrafted
Eastern San Joaquin	Mokelumne River (north/northwest); San Joaquin River (SJR) (west); Stanislaus River (south); consolidated bedrock (east)	707	X
Tracy[a]	Mokelumne River and SJR (north); Diablo Range (west); San Joaquin-Stanislaus County line (south); SJR (east)	345	
Modesto	Stanislaus River (north); SJR (west); Tuolumne River (south); Sierra Nevada foothills (east)	247	
Turlock	Tuolumne River (north); SJR (west); Merced River (south); crystalline basement rock of the Sierra Nevada foothills (east)	349	
Merced	Merced River (north); SJR (west); Madera-Merced County line (south); Sierra Nevada foothills (east)	491	X
Delta-Mendota[a]	Stanislaus-San Joaquin County line (north); Coast Ranges (west); Fresno Slough (south); SJR and Chowchilla Bypass (east)	747	X
Chowchilla[a]	Triangular region bounded by the southern boundary of the Merced Subbasin (north); SJR and the eastern boundary of the Columbia Canal Company Service Area (west); a border extending south of Dry Creek to the juncture of Merced, Mariposa, and Madera Counties (south and east)	159	X

Sources: DWR 2003a, 2003b, 2003c, 2003d, 2003e, 2003f, 2003g, 2003h, 2016.

[a] The Tracy, Delta-Mendota, and Chowchilla Subbasins comprise very little of the plan area.

Table 9-3. Characteristics of Freshwater Aquifers of the Northern San Joaquin Valley Groundwater Subbasins

	Subbasin Occurrence											
Aquifer Characteristic	Eastern San Joaquin	Tracy	Modesto	Turlock	Merced	Chowchilla	Delta-Mendota	Aquifer Age	Thickness (feet)	Estimated Yield (gpm)	General Description	Comments
Younger Alluvium		X	X	X	X	X		Recent	0–100	Can yield significant water	Dredge tailing and stream channel deposits	Unconsolidated sedimentary deposits.
Older Alluvium (undifferentiated)		X		X	X	X		Pliocene to Pleistocene	150	–[a]	Alluvial fan deposits	One of main water-yielding units of the unconsolidated sedimentary deposits.
Older Alluvium (differentiated)[b]			X					Pliocene to Pleistocene	100–650	–	Alluvial fan deposits	One of main water-yielding units of the unconsolidated sedimentary deposits.
Alluvium and Modesto/ Riverbank Formations	X						X	Recent to Late Pleistocene	0–150	650+	Alluvial and interfan deposits	

Aquifer Characteristic	Subbasin Occurrence							Aquifer Age	Thickness (feet)	Estimated Yield (gpm)	General Description	Comments
	Eastern San Joaquin	Tracy	Modesto	Turlock	Merced	Chowchilla	Delta-Mendota					
Flood basin deposits (undifferentiated)	X	X	X	X	X	X	X	Recent to Pliocene	0–1,400	Low	Flood basin deposits	Unconsolidated sedimentary deposits. Generally poor water quality with occasional areas of fresh water. Basinward (finer-grained) lateral equivalents of the Tulare, Laguna, Riverbank, Modesto, and Recent formations occur within the Delta.
Laguna Formation	X							Pliocene to Pleistocene	400–1,000	Average of 900, but up to 1,500	Fluvial	
Mehrten Formation	X		X	X	X			Miocene to Pliocene	200–1,200	Approximately 1,000	Reworked volcaniclastics (permeable) and dense tuff breccia (confining units)	

Aquifer Characteristic	Subbasin Occurrence							Aquifer Age	Thickness (feet)	Estimated Yield (gpm)	General Description	Comments
	Eastern San Joaquin	Tracy	Modesto	Turlock	Merced	Chowchilla	Delta-Mendota					
Tulare Formation		X					X		1,400	Up to 3,000	Clay, silt, and gravel	Poor water quality above the Corcoran Clay, which occurs near the top of the formation.
Ione Formation			X	X	X			Miocene		Generally low		Consolidated sedimentary deposits. Lies in eastern portion.
Valley Springs			X	X	X			Eocene		Generally low		Consolidated sedimentary deposits. Lies in eastern portion.
Lacustrine and marsh deposits			X		X	X		Pliocene to present	50–200	–		Corcoran or E-clay aquitard. Lies in western portion.
Continental deposits				X	X	X	X	Pliocene to present		Generally low		One of main water-yielding units of the unconsolidated sedimentary deposits.

	Subbasin Occurrence											
Aquifer Characteristic	Eastern San Joaquin	Tracy	Modesto	Turlock	Merced	Chowchilla	Delta-Mendota	Aquifer Age	Thickness (feet)	Estimated Yield (gpm)	General Description	Comments
Turlock Lake				X					150 (unconfined aquifer)	–		Unconsolidated sedimentary deposits. Lies in Western portion. Corcoran Clay aquitard separates into an upper unconfined and lower, confined aquifer.
Terrace deposits							X	Pleistocene		–		

Sources: DWR 2003a, 2003b, 2003c, 2003d, 2003e, 2003f, 2003g, 2003h.

gpm = gallons per minute

[a] California Department of Water Resources (DWR) has not estimated subbasin yield.

[b] Differentiated units are the Modesto, Riverbank, Victor, and Laguna formations.

Geology and Hydrogeology

Each groundwater subbasin may have multiple aquifers. Aquifers are underground layers of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater wells can pump water. Each subbasin can be described by its surface area, boundaries (at bedrock or along streams), and geological layers (physical characteristics). This section provides a description of groundwater basin geology and the distribution and movement of groundwater within subbasin aquifers in the plan area.

Two distinct geologic areas are located in the eastern and western portions of the San Joaquin Valley Groundwater Basin. The eastern portion of the basin contains the Ione, Mehrten, Riverbank, and Modesto formations, which are composed primarily of sediments originating from the Sierra Nevada. The western portion of the basin is composed of the Tulare Formation, which is the primary freshwater unit. The Tulare Formation originated as eroded sediments from the Coast Ranges deposited in the San Joaquin Valley as alluvial fan, flood basin, delta or lacustrine, and marsh deposits. The presence of thick, fine-grained lacustrine (originating in lakes) and marsh deposits distinguishes the Tulare Formation from other hydrologic units. These fine-grained units can be up to 3,600 feet (ft) thick in the Tulare Lake Groundwater Basin, but more commonly occur as regional, laterally extensive deposits tens to hundreds of feet thick that create vertically differentiated aquifer systems. The most widespread of these fine-grained units, the Corcoran Clay, divides the groundwater in the Tulare Formation into an upper semi-confined zone and a lower confined zone.

Freshwater-bearing aquifers within the subbasins include younger alluvium, older alluvium, flood basin deposits, lacustrine and marsh deposits, continental deposits, Turlock Lake, terrace deposits, Laguna Formation, Mehrten Formation, Tulare Formation, Alluvium and Modesto/Riverbank Formations, Ione Formation, and Valley Springs. The older alluvium consists of loosely and moderately compacted sand, silt, and gravel, is moderately to locally highly permeable, and is one of the main water-yielding units of the unconsolidated sedimentary deposits (City of Tracy 2011; DWR 2003a, 2003b, 2003c, 2003d, 2003e). The younger alluvium contains actively accumulating deposits, including sediments deposited in the channels of streams, and consists of unconsolidated silt, fine-to-medium grained sand, and gravel that are highly permeable and, where saturated, can yield significant amounts of water (City of Tracy 2011). Because of their fine-grained nature, flood basin deposits generally have low permeability and yield low quantities of water that is typically also of poor quality (City of Tracy 2011; DWR 2003a, 2003b, 2003c, 2003d, 2003e). The Tulare Formation generally yields poor-quality water above the Corcoran Clay layer, but contains freshwater deposits below the Corcoran Clay. The Alluvium and Modesto/Riverbank formations consist primarily of sand and gravel in the fan areas, while clay, silt, and sand are dominant in the interfan areas. Because these units are not very thick, most wells penetrate them to tap deeper aquifers. The Laguna Formation consists of discontinuous layers of stream-laid sand and silt, with lesser amounts of clay and gravel. Table 9-3 summarizes aquifer characteristics in each subbasin from which irrigation districts and water districts draw.

Groundwater Use and Budget

The subbasin water budget is the fundamental description of the groundwater conditions and is the basis for evaluating groundwater impacts. The storage volume for the subbasin may be quite large if the freshwater aquifers extend relatively deep (e.g., 500 ft); however, water surface elevation (or depths to groundwater) is more often used to describe the subbasin storage and to identify whether the subbasin storage is steady (sustainable) or in decline (in overdraft). The inflows to the basin (recharge) may be from adjacent subbasins; from overlying rivers and streams; or from infiltration from rainfall, irrigation canals, reservoirs, and water applied to crops (i.e., applied water). The outflows from the subbasin are predominantly pumping from wells by irrigation districts, municipalities, or individual users for irrigating crops or as potable water sources. However, outflows can also include seepage to springs and rivers when the groundwater elevation is higher than that of the surface water. Figure 9-2 shows a conceptual water budget with various inflows and outflows.

Irrigated agriculture accounts for approximately 95 percent of the total water use in the Modesto, Turlock, and Merced Subbasins, with municipal water use accounting for approximately the remaining 5 percent (USGS 2010). Of that total water use, groundwater accounts for approximately 38 percent of the total supply in the SJR Hydrologic Region (DWR 2013). As discussed in Chapter 13, *Service Providers*, many San Joaquin Valley cities rely on groundwater either wholly or partially to meet municipal needs.

Groundwater pumping in this region has caused a decrease in groundwater levels in recent years (DWR 2015a), which indicates that groundwater pumping is exceeding the amount of water that recharges the basin. When groundwater pumping is greater than recharge over a period of years, the basin or subbasin is considered overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. Overdraft can lead to significant impacts such as increased extraction costs, costs of well deepening or replacement, land subsidence, and degradation of groundwater quality (DWR 2003a).

Groundwater levels in the San Joaquin Valley Groundwater Basin have generally declined as a result of extensive agricultural pumping. Groundwater levels have declined by as much as 100 ft in some areas, primarily in the southern and western-most portions of the basin outside of the plan area (USGS 1999). In 2014, DWR evaluated groundwater elevation levels in California’s 515 alluvial groundwater basins and subbasins, prioritizing groundwater basins on multiple factors including reliance on groundwater as a primary source of water for municipal and agricultural use. DWR identified the four subbasins underlying the plan area as high priority (DWR 2014a). Subsequently, DWR was statutorily required to identify groundwater basins and subbasins in a condition of critical overdraft, which was defined as “when a continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.” The resulting list of 21 critically overdrafted basins included the Eastern San Joaquin, Merced and Chowchilla Subbasins (DWR 2016; Table 9-2).

Water Balance Processes within Subbasins

This section describes the movement of water into and out of the groundwater subbasins in the plan area and the resulting known effects on groundwater elevations. This section also describes known subsidence issues in and surrounding the plan area.

Horizontal Groundwater Flow

Patterns of groundwater movement and rates of recharge in the San Joaquin Valley Groundwater Basin have been significantly altered from pre-agricultural and urban development conditions. Prior to development, groundwater generally moved from recharge areas in the higher grounds surrounding the San Joaquin Valley towards the valley trough. Most groundwater discharges (i.e., losses) resulted from evapotranspiration and groundwater discharge to surface waters. In contrast, the majority of groundwater recharge in subbasins today comes from surface water for irrigation. Losses today typically result from groundwater pumped from both the shallow, semi-confined upper aquifer (400–800 ft) and lower confined aquifer(s) (500–4,000 ft) of the San Joaquin Valley Groundwater Basin (Trump 2008). This is generally true unless one aquifer is substantially more permeable or if local groundwater quality issues that affect groundwater pumping exist. Groundwater in the plan area generally moves from high ground down towards the SJR and Delta. However, groundwater may also move into areas of substantial drawdown, such as toward the cone of depression in the eastern half of the Turlock Subbasin or the high groundwater pumping areas west of the SJR (USGS 2015).

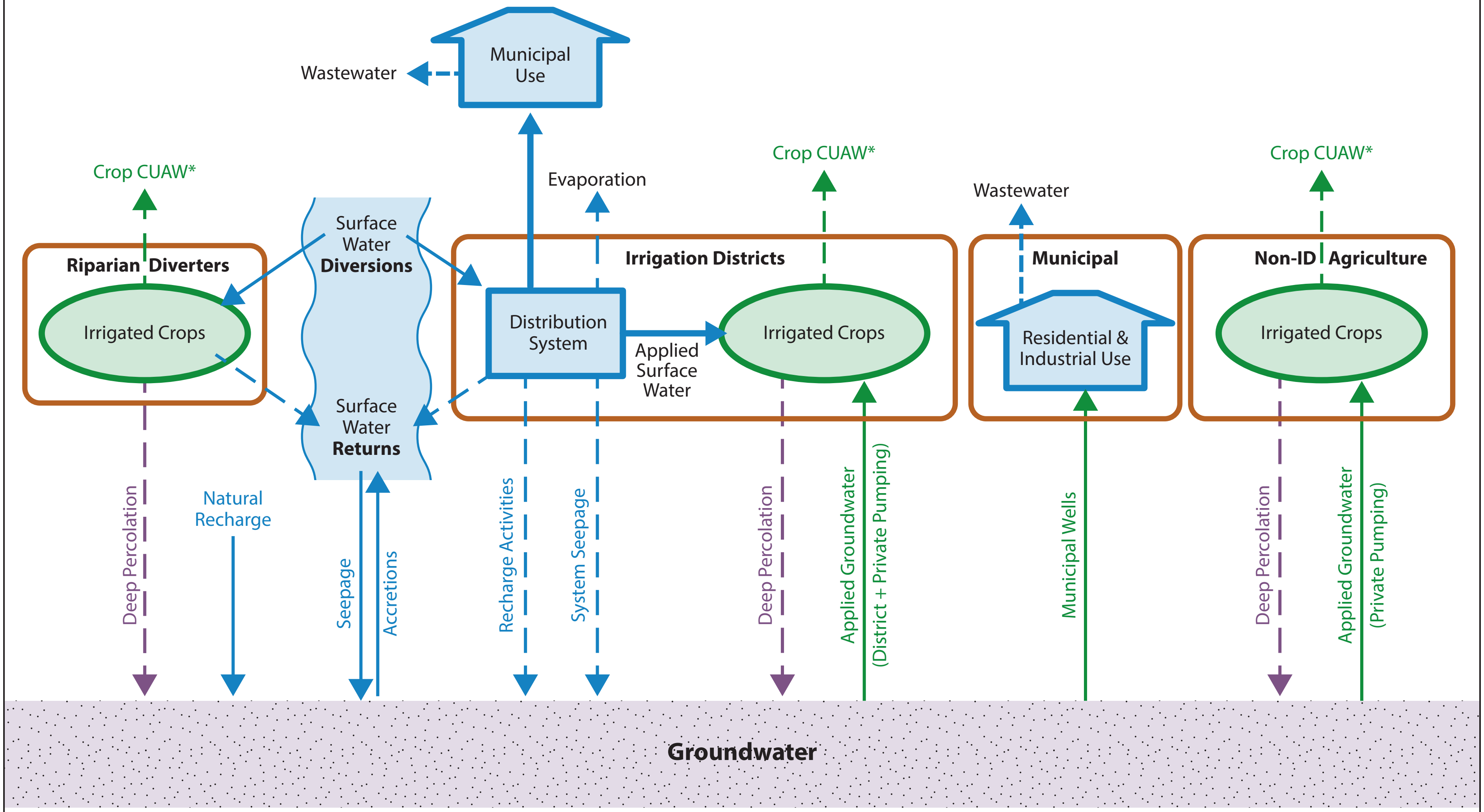
Inflows and Outflows

Each subbasin has a different surface area and different geological features (i.e., aquifer characteristics), and is subject to different pumping volumes. The inflows (i.e., recharge) are more difficult to estimate than outflows (e.g., pumping and other discharges), but the inflows must be similar to the pumping and other discharges in order to maintain groundwater levels in the subbasins. Mean annual rainfall in the plan area is low, ranging from 9 to 15 inches. Natural groundwater recharge from rainfall, streamflow, and lakes in the subbasins provide an important inflow component of the groundwater balance of each subbasin. This inflow is augmented by percolation of applied irrigation water and seepage from the distribution systems that convey this water (MAGPI 2008; TGBA 2008). Seepage originates from reservoirs, unlined water conveyances, and distribution canals. Major outflows occur through well pumping. However, other outflows include groundwater flowing to neighboring basins, seepage to springs, rivers, wetlands, and uptake by plants.

Interaction between Rivers and Groundwater

Stream seepage from the Stanislaus, Tuolumne, and Merced Rivers provides some portion of recharge to the underlying groundwater aquifers. Groundwater can flow to springs or rivers when the river elevation is less than the nearby groundwater elevation. Some sections of rivers are “losing” (i.e., the river recharges the groundwater) and other sections of rivers are “gaining” (i.e., groundwater discharges to the river). The upper reaches of the Stanislaus, Tuolumne, and Merced Rivers (downstream of Goodwin, La Grange, and Crocker-Huffman Dams) are losing rivers, with groundwater recharged by streamflow. The lower reaches of the rivers are gaining rivers, with groundwater discharging to the rivers (TGBA 2008; MAGPI 2008). Between 1997 and 2006, the net groundwater discharge to the lower reaches of the Tuolumne and Merced Rivers and along the entire reach of the SJR was estimated as a combined average of nearly 30 thousand acre-feet per year (TAF/y) (TGBA 2008). Other studies indicate that the SJR downstream of the Merced River is gaining (USGS 2015). Modeling results of groundwater-surface water interactions are not entirely consistent with this upstream versus downstream pattern. For example, based on modeling results performed for San Joaquin County to simulate a 5-year period (1989–1993), the Tuolumne River and upper SJR were gaining rivers, while the Stanislaus River and LSJR (from the Merced River to Vernalis) were losing rivers (NSJCGBA 2004).

In either the losing or gaining scenario, groundwater-surface water interactions are unlikely to have a large impact on total river flow. A recent modeling study of a region east of the SJR extending from north of the Stanislaus River to south of the Merced River indicated that groundwater-surface water interactions have a relatively small effect on river flow, generally changing flow by plus or minus 2 cubic feet per second (cfs) per mile (USGS 2015).



* CUAW = Consumptive Use of Applied Water

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Figure 9-2
Conceptual Water Budget

The depth to groundwater table (i.e., elevation of standing water in wells) of the near-surface unconfined aquifer is controlled by the surface water elevations of rivers and the amount of water moving in and out of the aquifer. SJR elevation generally increases from approximately 20 ft above mean sea level (MSL) in the north (mouth of Stanislaus River), to approximately 80 ft above MSL in the south (near the Merced–Madera County line), and to approximately 150–200 ft above MSL in the eastern portions of the subbasins along the Sierra Nevada foothills

Groundwater Balance and Elevations

A groundwater balance occurs naturally in an undeveloped aquifer system where inflows and outflows of groundwater are equal. Pumping for urban or agricultural uses changes the balance of the system and may lead to declining groundwater levels and land subsidence (USGS 1999). The general water balance condition (i.e., sustainable pumping or overdraft) of a subbasin can be identified by observing groundwater elevations over a number of years. Declining groundwater levels indicate overdraft, which occurs when average outflow from a subbasin exceeds average inflow to a subbasin. Steady or rising groundwater levels indicate that average pumping is less than or equal to the average net inflow. Increasing pumping in a subbasin is likely to reduce the average groundwater level (i.e., drawdown), with a noticeable effect on groundwater levels over a number of years.

Sustainable (or safe) yield represents a level of groundwater pumping that will not harm other resources. However, it is difficult to determine the sustainable yield of a subbasin because of the large degree of uncertainty associated with all components of the water budget. This includes the difficulty of determining whether a certain level of groundwater pumping will reduce accretions to surface water bodies by an amount that will be detrimental to surface water resources. Furthermore, sustainable yield estimates are highly dependent on recharge from surface water applications for irrigation and seepage from distribution systems. As such, if surface water applications are modified, then the subbasin's sustainable yield changes.

DWR and other agencies monitor groundwater elevations through a network of wells. Each groundwater management plan (GWMP, discussed in Section 9.3.3, *Regional or Local [Regulatory Background]*) prepared for the subbasins includes groundwater elevation contours for each year or every 3–5 years. The depth to groundwater in each well can also be plotted to determine the increases and decreases in the groundwater elevations through time. Groundwater elevations generally decrease during drought periods because the balance between recharge from surface irrigation and pumping for irrigation shifts to more pumping. This shift results in less recharge to the subbasins from surface water diversions and deliveries. Seasonal changes can also affect water table elevations. For example, groundwater elevations may increase slightly during the winter, from higher recharge, and decrease during the summer, from increased groundwater pumping. Seasonal changes in groundwater elevations are less apparent in subbasins with substantial surface water deliveries because the increased pumping coincides with the increased surface water recharge (from canals and applied water).

Figure 9-3 shows recent (2010) groundwater elevations in the San Joaquin Valley portion of the SJR region. The elevation contours show that groundwater elevations are shallowest along the Central Valley floor adjacent to the SJR and its tributaries, and are deepest along the eastern side of the Central Valley, where it abuts the lower foothills of the Sierra Nevada. The elevation contours also show areas of lower elevation (e.g., cones of depression) in some portions of the Turlock and Eastern San Joaquin subbasins (DWR 2015a). Between 2005 and 2010 the subbasins underlying the plan area saw generally small changes in groundwater elevations (Figure 9-4). However, larger decreases occurred along the eastern edges of the irrigation districts and some areas near and east of Stockton experienced increases in groundwater levels (DWR 2015a). More information regarding groundwater elevations related to each subbasin is provided in Section 9.2.2, *Subbasin Groundwater Use*.

Figure 9-5 shows the depth below ground surface to the groundwater level as contours for the San Joaquin Valley portion of the SJR region. The depth to groundwater is generally less than 20 ft along the SJR and western portions of each subbasin underlying the plan area, and increases to more than 100 ft in the eastern portions of the subbasins underlying the plan area. Despite intensive agricultural practices predominant in the valley, depth to groundwater is shallowest along the SJR because the volume of water transferred by SJR tributaries has resulted in a high, near-surface water table as an outcome of recharging shallow aquifers. The deeper depths to groundwater in the eastern portions of the subbasins are due to widespread agricultural development and a lack of surface water. In some locations near the SJR, groundwater is too close to the surface for agriculture, and districts have resorted to pumping groundwater to enhance drainage (DWR 2015a). However, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) have decreased their drainage pumping between 1960 and 2004 (USGS 2015).

Although much of the plan area saw only small changes in groundwater elevations in recent years (Figure 9-4), the San Joaquin Valley has a long history of declining groundwater levels due to overpumping. The most significant decline has occurred south of the study area; however, the four subbasins underlying the study area have all experienced groundwater level declines and overdraft (Table 9-4). The average groundwater level decline is difficult to estimate from scattered wells with incomplete data through time. Overdraft estimates vary because of the use of different data, time periods, and underlying assumptions. Much of the data is incomplete or only represents a certain geography (e.g., county) of a total subbasin. Further, numbers can vary widely depend on what time period reviewed and specific yield[7] values used. Withdrawals and recharge from unconsolidated heterogeneous aquifer systems, like those underlying many locations in the San Joaquin Valley causes measurable elastic (recoverable) land subsidence. Removing water from storage in fine-grained silts and clays that are interbedded in the aquifer system can cause these highly compressible sediments to compact inelastically and permanently. Land subsidence from inelastic (non-recoverable) compaction is a common consequence of the significant groundwater level changes that can result from dependence on groundwater (Borchers et al. 2014).

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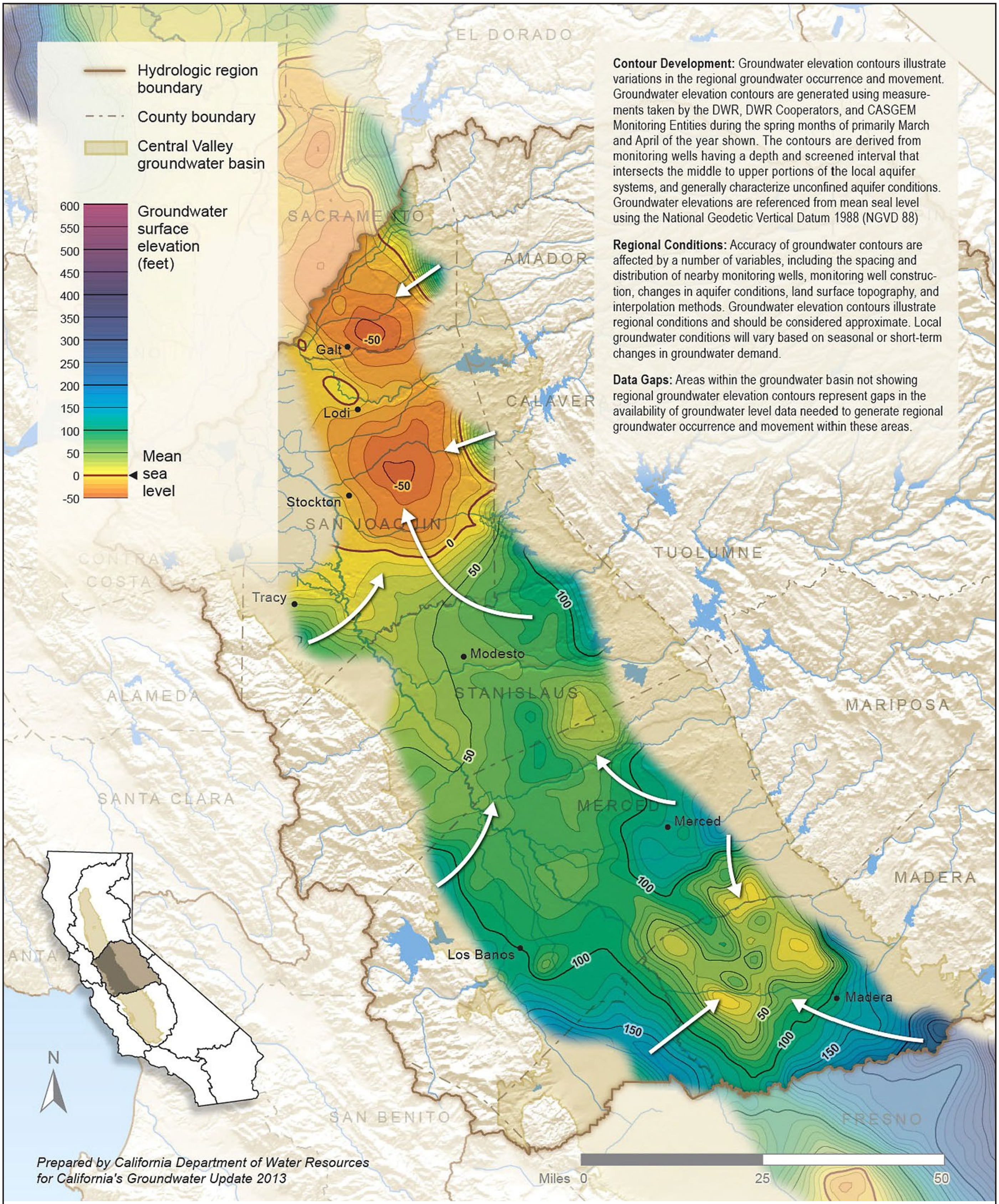
[7] *Specific yield* is the ratio of the volume of water a saturate soil will yield by gravity drainage to the total volume of the soil.



Contour Development: Groundwater elevation contours illustrate variations in the regional groundwater occurrence and movement. Groundwater elevation contours are generated using measurements taken by the DWR, DWR Cooperators, and CASGEM Monitoring Entities during the spring months of primarily March and April of the year shown. The contours are derived from monitoring wells having a depth and screened interval that intersects the middle to upper portions of the local aquifer systems, and generally characterize unconfined aquifer conditions. Groundwater elevations are referenced from mean seal level using the National Geodetic Vertical Datum 1988 (NGVD 88)

Regional Conditions: Accuracy of groundwater contours are affected by a number of variables, including the spacing and distribution of nearby monitoring wells, monitoring well construction, changes in aquifer conditions, land surface topography, and interpolation methods. Groundwater elevation contours illustrate regional conditions and should be considered approximate. Local groundwater conditions will vary based on seasonal or short-term changes in groundwater demand.

Data Gaps: Areas within the groundwater basin not showing regional groundwater elevation contours represent gaps in the availability of groundwater level data needed to generate regional groundwater occurrence and movement within these areas.

Prepared by California Department of Water Resources for California's Groundwater Update 2013

Source: Figure 8-13 from DWR 2015.

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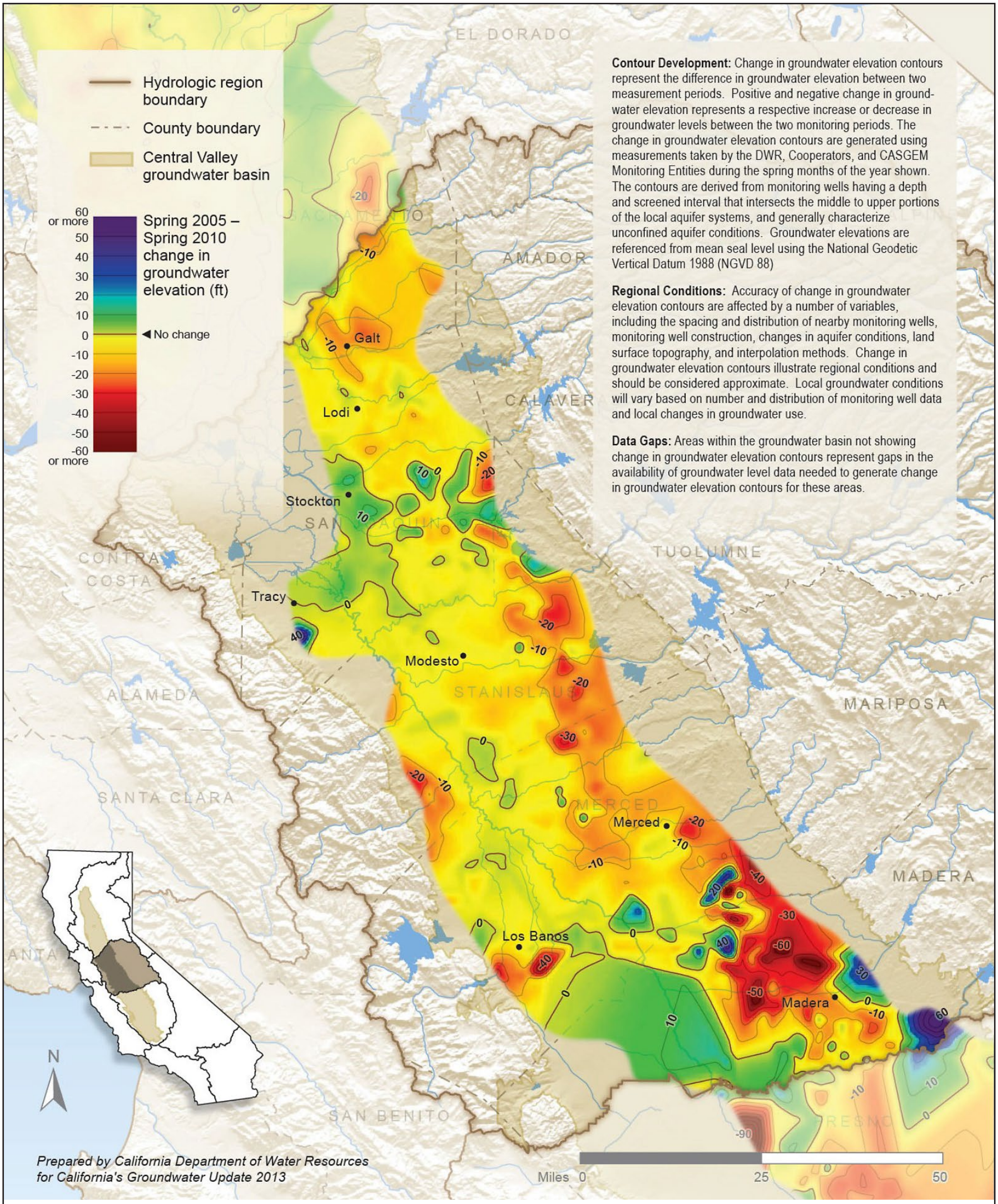
Figure 9-3
Spring 2010 Groundwater Elevation Contours for the San Joaquin Valley Portion of the San Joaquin River Hydrologic Region



Contour Development: Change in groundwater elevation contours represent the difference in groundwater elevation between two measurement periods. Positive and negative change in groundwater elevation represents a respective increase or decrease in groundwater levels between the two monitoring periods. The change in groundwater elevation contours are generated using measurements taken by the DWR, Cooperators, and CASGEM Monitoring Entities during the spring months of the year shown. The contours are derived from monitoring wells having a depth and screened interval that intersects the middle to upper portions of the local aquifer systems, and generally characterize unconfined aquifer conditions. Groundwater elevations are referenced from mean seal level using the National Geodetic Vertical Datum 1988 (NGVD 88)

Regional Conditions: Accuracy of change in groundwater elevation contours are affected by a number of variables, including the spacing and distribution of nearby monitoring wells, monitoring well construction, changes in aquifer conditions, land surface topography, and interpolation methods. Change in groundwater elevation contours illustrate regional conditions and should be considered approximate. Local groundwater conditions will vary based on number and distribution of monitoring well data and local changes in groundwater use.

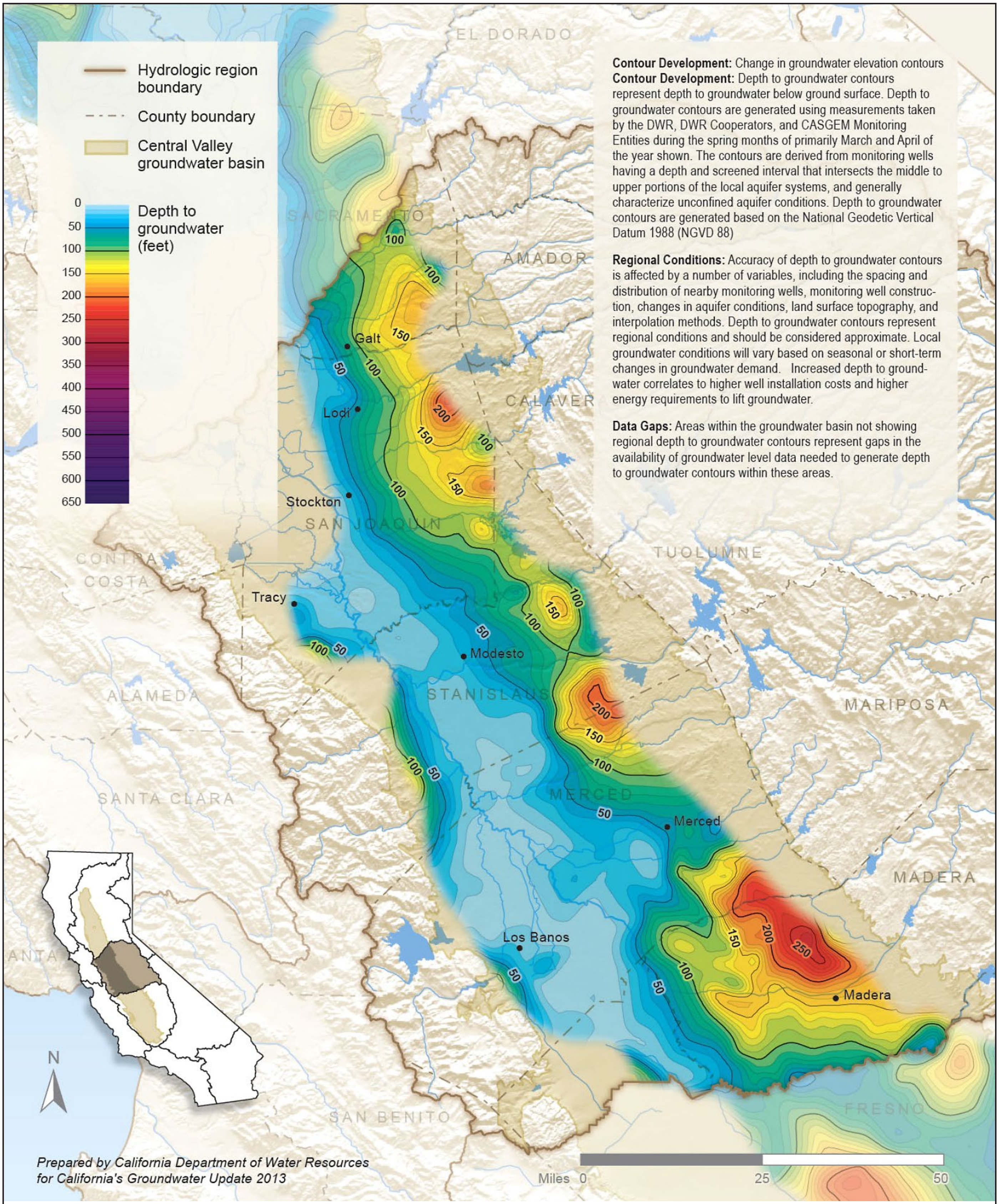
Data Gaps: Areas within the groundwater basin not showing change in groundwater elevation contours represent gaps in the availability of groundwater level data needed to generate change in groundwater elevation contours for these areas.

Prepared by California Department of Water Resources for California's Groundwater Update 2013

Source: Figure 8-15 from DWR 2015.

Graphics...00427.11 (10-2-2015)

Figure 9-4
Change in Groundwater Elevation Contour Map for the San Joaquin Valley Portion of the San Joaquin Hydrologic Region (Spring 2005-Spring 2010)



Contour Development: Change in groundwater elevation contours
Contour Development: Depth to groundwater contours represent depth to groundwater below ground surface. Depth to groundwater contours are generated using measurements taken by the DWR, DWR Cooperators, and CASGEM Monitoring Entities during the spring months of primarily March and April of the year shown. The contours are derived from monitoring wells having a depth and screened interval that intersects the middle to upper portions of the local aquifer systems, and generally characterize unconfined aquifer conditions. Depth to groundwater contours are generated based on the National Geodetic Vertical Datum 1988 (NGVD 88)

Regional Conditions: Accuracy of depth to groundwater contours is affected by a number of variables, including the spacing and distribution of nearby monitoring wells, monitoring well construction, changes in aquifer conditions, land surface topography, and interpolation methods. Depth to groundwater contours represent regional conditions and should be considered approximate. Local groundwater conditions will vary based on seasonal or short-term changes in groundwater demand. Increased depth to groundwater correlates to higher well installation costs and higher energy requirements to lift groundwater.

Data Gaps: Areas within the groundwater basin not showing regional depth to groundwater contours represent gaps in the availability of groundwater level data needed to generate depth to groundwater contours within these areas.

Prepared by California Department of Water Resources for California's Groundwater Update 2013

Graphics...00427.11 (10-2-2015)

Source: Figure 8-12 from DWR 2015.

Figure 9-5
Spring 2010 Depth to Groundwater Contours for the San Joaquin Valley Portion of the San Joaquin River Hydrologic Region

Table 9-4. Estimates of Average Groundwater Level Decline and Overdraft in the Plan Area Subbasins

	Water Level Decline		Overdraft				
Subbasin	DWR Bulletin 118 (in/y)	DWR Ground-water Update 2013 (in/y)	DWR Bulletin 118[a] (TAF/y)	VAMP Supple-mental EIR (TAF/y)	Turlock GW Basin Association (2008)[b] (TAF/y)	Turlock GW Basin Association (2003)[b] (TAF/y)	Merced County General Plan Update (2009) (TAF/y)
Eastern San Joaquin	20	5.3	88	–	–	–	–
Modesto	6.0	17	11	15	–	–	–
Turlock	2.8	20	9	85	21.5	30	–
Merced	12	27	44	20	–	–	27
Time Period	1970–2000	2005–2010	1970–2000	1960–1992[c]	1997–2006	1953–2002	1980–2007

Sources: DWR 2015b; DWR 2003b; DWR 2003c; DWR 2003d; DWR 2003e; USBR and SJRGA 2001; TGBA 2008; TGBA 2003; County of Merced 2009.

Note: The average groundwater level decline is difficult to estimate from scattered wells with incomplete data through time. Overdraft estimates vary because of the use of different data, time periods, and underlying assumptions.

DWR = California Department of Water Resources
EIR = Environmental Impact Report
in/y = inches per year
TAF/y = thousand acre-feet per year
GW = groundwater
VAMP = Vernalis Adaptive Management Plan
– = no data

[a] Values based on average water level decline, subbasin acres, and specific yield from DWR Bulletin 118.

[b] The overdraft is primarily located in the eastern part of the Turlock Subbasin.

[c] Exact years vary: Modesto Subbasin 1970–1990; Turlock 1971–1991; Merced Subbasin 1960–1992.

The extensive withdrawal of groundwater from the unconsolidated deposits has causes widespread land subsidence in the San Joaquin Valley (USGS 1986). Long-term groundwater level declines can result in a vast one-time release of "water of compaction" from compacting silt and clay layers in the aquifer system, which causes land subsidence (USGS 1999). Land subsidence in the region due to groundwater pumping began in the mid-1920s (USGS 1975; USGS 1991; USGS 1999). As surface water imports increased during the early 1950s through early 1970s and groundwater pumping decreased, groundwater levels began to recover and reduced the rate of land subsidence in some areas (USGS 1986). During the droughts of 1976–1977 and 1987–1992, reduced surface water availability once again led to increased groundwater pumping and re-initiating subsidence in the San Joaquin Valley. However, following each of these droughts, recovery to pre-drought water levels was rapid and subsidence virtually ceased (Swanson 1998; USGS 1999). During the more recent droughts of 2007–2009 and 2012–present, groundwater pumping and subsidence has increased in some parts of the San Joaquin Valley (Faunt 2015), including in the southern portion of the study area.

In the southern portion of the study area, increased dependence on groundwater during the recent drought resulted in groundwater levels approaching or surpassing historic lows, which caused aquifer-system compaction and land subsidence that most likely is permanent (Sneed and Brandt 2015). Between 2008 and 2010, the southern portion of the study area (Extended Merced Subbasin) experienced some level of subsidence, with the highest subsidence rate occurring around El Nido, which saw a decline of 540 millimeters (mm) (subsidence rate of 270 mm/y). This is among the highest subsidence rates ever measured in the San Joaquin Valley. Assuming the same rate of subsidence occurred during 2007–2014 as occurred during 2008–2010 at the local subsidence maximum near El Nido, approximately 2 meters of subsidence may have occurred during 2007–2014 (Sneed and Brandt 2015; Farr et al. 2015). The periphery of the El Nido subsidence area, both inside and outside the study area, showed seasonally variable subsidence and compaction rates. Groundwater-dependent areas that have not historically depended on surface water supplies experienced fairly consistent rates of groundwater level decline during and between drought periods. Those areas that increased groundwater-dependence while surface water was curtailed experienced subsidence during the drought periods, but very little subsidence between drought periods (Sneed and Brandt 2015).

9.2.2 Subbasin Groundwater Use

This section provides an overview of groundwater use in the four main subbasins underlying the plan area (Eastern San Joaquin, Modesto, Turlock, and Merced) and allows for comparisons between subbasins. The overview is followed by more specific information for each subbasin, including information about irrigation districts, and the groundwater and surface water users of each irrigation district.

In some cases, the numeric values provided in the overview differ from the values in specific subbasin sections; this is due to differences in agencies' analysis. For example, most numbers shown in the tables are from DWR Bulletin 118, while other data and information come from county databases, DWR's 2013 Water Plan Groundwater Update (DWR 2015a), irrigation district agricultural water management plans (AWMPs), GWMPs, integrated regional water management plans (IRWMPs), and urban water management plans (UWMPs). While numbers may be inconsistent throughout this section, in general, the inconsistencies are minor and support scientifically sound conclusions about groundwater trends within the subbasins and the irrigation districts. Irrigation districts manage groundwater resources within their service areas; the groundwater subbasins underlying the plan and study areas are not adjudicated (DWR 2011).

More than half of all land within the study area is irrigated agriculture and the largest use of groundwater is for agricultural purposes. Although agricultural groundwater pumping is not generally measured, total groundwater pumping in each subbasin can be estimated indirectly from the DWR agricultural land surveys. The estimate uses the acres of each crop category within each subbasin or irrigation district boundary. Surface water is assumed to provide the majority of the irrigation districts' water; groundwater pumping is estimated for the irrigated areas that are not supplied with surface water.

Irrigation districts that divert water from the Stanislaus, Tuolumne, or Merced Rivers or the LSJR may also pump groundwater from the subbasins for agricultural or domestic water supplies. These irrigation districts include: South San Joaquin Irrigation District (SSJID), Oakdale Irrigation District (OID), Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD), MID, TID, and Merced Irrigation District (Merced ID). Throughout the rest of this chapter, these districts that regularly receive surface water from the Stanislaus, Tuolumne, and Merced Rivers are collectively referred to as the "irrigation districts."

Other water suppliers in the study area include the Northern San Joaquin Water Conservation District (NSJWCD), Woodbridge Irrigation District (WID), Eastside Water District (EWD), and Ballico-Cortez Water District (BCWD). NSJWCD and WID pump groundwater from the northern portion of the Eastern San Joaquin Subbasin and receive surface water from the Mokelumne River (NSJCGBA 2004). EWD and BCWD are large groundwater users in the Turlock Subbasin; they also receive some surplus surface water from TID and Merced ID during wet weather seasons (TGBA 2008).

Table 9-5 shows the number of irrigated acres that lie within each groundwater subbasin separated by whether the acres are within or outside of the irrigation districts. These acres were estimated using information from the AWMPs prepared by irrigation districts in recent years (2012–2014) and DWR's 2010 agricultural land survey.[8] For more information, see Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

The total irrigated land within each subbasin generally indicates the potential for agricultural pumping effects on the subbasin water balance. The Modesto Subbasin has the fewest acres of irrigated land overall, both by acreage and by percentage (116,000 acres and 47 percent total land, respectively) and the Turlock Subbasin has the greatest percentage of irrigated land (77 percent). However, the best indication of the potential for groundwater impacts that may occur if surface water diversions are reduced in drought years is the percentage of the irrigated area that falls within the irrigation district service areas and usually relies on surface water. Within irrigation district service areas, the Merced Subbasin has the fewest number of irrigated acres, both by acreage and by percentage (86,000 acres and 32 percent, respectively); the Modesto Subbasin has the greatest number of irrigated acres that falls within irrigation district service areas, when determined by percentage (77 percent).

Groundwater Quality

Groundwater quality varies substantially throughout the San Joaquin Valley Groundwater Basin. Poor water quality conditions caused by agricultural and industrial contaminants are more common in the surface aquifer at shallower depths. In addition to agricultural and industrial sources, trace elements (such as arsenic, manganese, vanadium, and uranium) that are naturally occurring in rocks and soils can come in contact with the water and present water quality problems.

Groundwater quality of the subbasins varies depending on the location, substrate material, and land use (e.g., agricultural or urban). The State Water Board's Groundwater Ambient Monitoring and Assessment Program (GAMA), referenced under Section 9.3.2, *State [Regulatory Background]*, provides a comprehensive assessment of the State's groundwater quality. GAMA's Priority Basin Project included the four groundwater basins in the study area. While GAMA demonstrated that groundwater quality in the four subbasins is relatively good (i.e., low salinity and low contaminant levels), organic constituents (i.e. volatile organic compounds [VOCs] and pesticides) and inorganic constituents (i.e., trace elements and nutrients such as nitrite and nitrate) have been detected in some of the primary aquifers in the study area. The GAMA Priority Basin Project is discussed in greater detail in Chapter 13, *Service Providers*.

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[8] DWR 2010 agricultural land survey data are available as geographic information systems (GIS) coverages for each of DWR's Detailed Analysis Units (DAU).

Elevated salinity levels, measured as total dissolved solids (TDS) or electrical conductivity (EC),[9] are common in San Joaquin Valley groundwater. Salinity is generally lower along the eastern side of the San Joaquin Valley Groundwater Basin than on the western side, and is generally higher in the shallow aquifer than the deep aquifer. The relatively low groundwater salinity on the eastern side can be attributed to the low salinity of Sierra Nevada runoff and application of surface water as a major irrigation source in the subbasins. However, there are some localized issues. For example, increased levels in groundwater salinity have been detected in the Stockton area due to a lateral saline front to the west (NSJCGBA 2004). In the Merced Groundwater Basin, high TDS concentrations are principally the result of the migration of a deep saline water body which originates in regionally deposited marine sedimentary rocks that underlie the San Joaquin Valley. Under natural pressure, the saline groundwater body is migrating upward. But pumping by deep wells in the western and southern parts of the Merced Subbasin may be causing these saline brines to upwell and mix with fresh water aquifers more rapidly than under natural conditions (MAGPI 2008).

As discussed above, over pumping of groundwater has been depleting the groundwater resources in the Central Valley. A change in groundwater gradient associated with groundwater pumping can indirectly influence groundwater quality in the subbasins. If there is a source of groundwater contamination in an area, groundwater pumping can influence the movement of contaminants toward wells. See Section 13.2.1, *Lower San Joaquin River and Tributaries,* for details of how over-pumping can affect groundwater quality.

For example, while the San Joaquin Valley is not characterized by high concentrations of nitrates at the depth zone used for public supply, application of fertilizers and animal manure to agricultural land has caused downward movement of nitrates into the soil. As groundwater pumping continues and as irrigation water containing elevated concentrations of nitrate moves toward and through deeper parts of the aquifer, high concentrations of nitrates in the public water supply could be a concern in the future (Belitz et al. 2015).The slow movement of water from the surface through the unsaturated zone to deep aquifers means that it may be many years after a persistent chemical has entered the ground before it affects the quality of groundwater supplies (Morris et al. 2003). Although the occurrence of trace elements (e.g., arsenic and uranium) is not anthropogenic, these elements can leach into groundwater and be mobilized by human activities (Smedley and Kinniburgh 2002; Barringer and Reilly 2013). For example, the downward infiltration of irrigation water with elevated bicarbonates caused movement of uranium in an area of the eastern San Joaquin Valley (Belitz et al. 2015).

Over 98 percent of Californians using a public water supply receive safe drinking water that meets all health standards (State Water Board 2013). In general, municipal drinking water wells do not exceed federal and state maximum contaminant levels (MCLs) for water quality. This is because municipal wells are generally deep, and water quality tends to be better in deeper aquifers. Furthermore, water quality is managed such that if the concentration of contaminants in well water exceeds criteria, the well can be brought offline or its water can be blended with higher quality water from other wells. In addition, water quality in community water systems are frequently

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[9] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

monitored by the Division of Drinking Water and the service providers pursuant to various regulatory requirements stated in Section 13.3, *Regulatory Background*.

However, drinking water quality is still a concern in some areas of the four subbasins. Between 2002 and 2010, approximately one-fifth of the state's active community water system wells used by groundwater-reliant communities (i.e., groundwater is the primary source of drinking water) had contaminated groundwater with detections above an MCL two or more times (State Water Board 2013). Of the 510 active wells (serving 148 community water systems) within the four subbasins, 134 wells (serving 54 community water systems) had two or more MCL exceedances between 2002 and 2010. These exceedances reflect raw, untreated groundwater quality; as stated above, water systems that rely on contaminated groundwater typically treat their well water before it is served to the public. For example, the City of Livingston recently improved filtration in order to reduce arsenic concentrations that were above the state's MCL (Giwargis 2014).

Private drinking water wells may have more significant water quality issues than municipal wells because they are often shallower than municipal wells and, therefore, are more susceptible to surface contaminants. However, the state does not regulate the water quality of private drinking water wells, and does not require private drinking water well owners to test for water quality. As such, there is no comprehensive dataset on private drinking water quality, and there is a lack of water quality data for private drinking water wells within the study area.

Although, as stated above, groundwater pumping can influence the movement of contaminants toward wells, specifically determining the changes to groundwater quality is speculative as it is dependent of many factors including, but not limited to, location and depth of the well, the amount and frequency of groundwater pumping, number and proximity of nearby wells, hydrogeological characteristics of the aquifer (e.g., consolidated clays with low permeability or unconsolidated sands with high permeability), distance between the well(s) and the contaminant(s), contaminant characteristics (e.g., highly mobile in water or adhering primarily to soil), and land use near the well. Groundwater quality may also be affected by other factors such as improperly constructed wells that interconnect groundwater strata or introduce surface waters into underground waters (Wat. Code, § 231) or by unused or abandoned wells that, due to the pumping of nearby wells, can draw poor quality water down and into the drinking water aquifer (State Water Board 2015).

Table 9-5. Summary of Irrigated Land in the Plan Area Subbasins

Subbasin	Total Land (1,000 acres)	Total Irrigated Area (1,000 acres and percent of total land)	Total Irrigated Area: Outside Irrigation Districts (1,000 acres and percent of total irrigated area)	Total Irrigated Area: Within Irrigation Districts (1,000 acres and percent of total irrigated area)
Eastern San Joaquin	707	386 (55%)	192 (50%)	194 (50%)
Modesto	247	116 (47%)	27 (23%)	89 (77%)
Turlock	349	269 (77%)	118 (44%)	151 (56%)
Merced	491	269 (55%)	182 (68%)	86 (32%)
Total	1,794	1,039 (58%)	518 (50%)	521 (50%)

Note: Irrigated acres are based on GIS analysis of DWR 2010 agricultural land survey data, at the detailed analysis unit (DAU) level, and 2012 AWMPs. For more information, see Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Table 9-6 shows the estimated groundwater pumping in each subbasin. The estimated groundwater pumping for normal years within the subbasins is estimated based on the acres of irrigated lands outside of the irrigation districts, the volume of municipal pumping for cities, and the minimum pumping volume reported within each irrigation district in normal years with full surface water diversions. Groundwater pumping for irrigated lands outside of the irrigation districts is estimated by multiplying estimates of applied water rates for different crop types by the number of acres of each crop type, as described in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Groundwater pumping for irrigated lands outside the irrigation districts remains relatively constant during droughts. This is because crop needs are generally met with groundwater regardless of surface water availability (although crops may require more applied water in drought years than in normal years). However, groundwater pumping for irrigated lands within the irrigation districts typically increases in years when the available surface water supply is reduced. When surface water diversions are reduced during dry years, irrigation districts (or individual growers) may increase groundwater pumping to compensate for a portion of, or all of, the reduced surface water diversions. If historical conditions have provided nearly full surface water diversions in most years, an irrigation district may have a limited a capacity in regards to the quantity of groundwater that can be pumped. Minimum and maximum groundwater pumping in the irrigation districts are estimated, as described in Appendix G. Minimum groundwater pumping is expected every year; whereas maximum groundwater pumping is expected only when surface water is in such short supply that irrigation district wells would be fully utilized.

Table 9-6 Estimated Groundwater Pumping in the Plan Area Subbasins

Subbasin	Districts	District Irrigated Lands (1,000 acres)	Minimum Pumping (TAF/y)[a]	Maximum Pumping (TAF/y)[a]	Municipal Pumping (TAF/y)[b]	Irrigated Land Outside Districts (1,000 acres)	Pumping for Irrigated Lands Outside of Districts (TAF/y)[a, c]	Minimum Total Pumping (TAF/y)
Eastern San Joaquin	Total	194	167	353	47	192	446	658
	SSJID	59	26	59				
	OID north	23	8	17				
	SEWD and CSJWCD[d]	99	133	264				
	WID[e]	13	NA	0				
Modesto	Total	89	22	50	81	27	83	187
	OID south	31	10	22				
	MID	59	12	28				
Turlock	Total	151	82	137	65	118	351	498
	Turlock ID	146	81	125				
	Merced ID north	5	2	13				
Merced	Total	86	32	218	54	182	556	642
	Merced ID[f]	86	32	218				

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Conservation District
TID = Turlock Irrigation District
MID = Modesto Irrigation District
Merced ID = Merced Irrigation District
WID = Woodbridge Irrigation District
TAF/y = thousand acre-feet per year.
NA = Not Applicable (because groundwater pumping for WID land that is not supplied by surface water is included with the pumping for lands outside of the irrigation districts).

[a] Values derived as described in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*. These values are for the 2009 base year. Minimum and maximum pumping estimates for 2014 were also assessed as described in Section 9.4.3, *Impacts and Mitigation Measures*, and Appendix G.

[b] Source: Domestic/municipal pumping from DWR Bulletin 118 (DWR 2003a, 2003b, 2003c, 2003d, 2003e).

[c] Values may be slightly high because some surface water may be available to these areas (e.g., some Mokelumne River water for NSJWCD, some Merced ID deliveries to land outside the District, and surface water diversions by riparian users along the rivers).

[d] Minimum pumping estimate assumes that SEWD provides 50 TAF/y for urban use (based on SEWD AWMP) and that SEWD receives 67 TAF/y from Calaveras River (NSJCGBA 2004). Of the 99,000 acres of irrigated land, approximately 48,000 belongs to CSJWCD and 51,000 belongs to SEWD.

[e] Portion of Woodbridge ID with surface water supply from the Mokelumne River. This information is relevant because it means that this land within the subbasin does not depend entirely on groundwater.

[f] Merced ID irrigated land and groundwater pumping estimated for the Turlock and Chowchilla Subbasins not included.

Eastern San Joaquin Subbasin

The Eastern San Joaquin Subbasin has approximately 386,000 acres of irrigated land; 50 percent of these acres are potentially supplied with surface water from SSJID, OID, SEWD, CSJWCD, and WID (Table 9-5). The subbasin underlies the Cities of Manteca, Lathrop, and Stockton, which use groundwater for a large portion of their drinking water supply.

The Eastern San Joaquin Subbasin has been well studied. Unlike the other three subbasins discussed in this chapter (Modesto, Turlock, and Merced), there have been multiple efforts to estimate the water budget components and the subbasin's sustainable yield. Bulletin 118 (DWR 2003b) presents results from two studies. One study estimated a sustainable yield of approximately 740 TAF/y, based on the estimated agricultural pumping (762 TAF/y) plus municipal and industrial pumping (47 TAF/y) minus the overdraft (70 TAF/y) (SJCFCWCD 1985). The other study estimated the sustainable yield of San Joaquin County, which includes more than the Eastern San Joaquin Subbasin, to be 618 TAF/y (USBR 1996). Historically, pumping from agricultural, urban, and rural, wells has been greater than the subbasin's safe yield (SSJID 2012). The subbasin's estimated minimum total agricultural and municipal groundwater pumping is 658 TAF/y (Table 9-6). This pumping estimate represents a minimum amount of pumping; actual average pumping is greater in some years, especially during dry years when surface water supply is reduced.

Declining groundwater levels over a period of time indicate that groundwater use within a subbasin is unsustainable. Groundwater levels have declined over the past 40 years at an average rate of 1.7 feet per year (ft/y) and have dropped as much as 100 ft in some areas (USACE 2001). As of 2010, there was a fairly large cone of depression centered east of Stockton below SEWD and CSJWCD service areas (Figure 9-3). However this cone of depression is not as severe as it once was; between 2005 and 2010, groundwater elevations within some portions of this area showed some signs of improvement (Figure 9-4). During the recent drought, groundwater levels in the San Joaquin County continued to decline; between Spring 2014 and Spring 2015 average groundwater levels declined an average of 3 ft throughout the county, and between Spring 2015 and Spring 2016, average groundwater levels declined an additional 2 ft throughout the county (Breitler 2016). Additionally, reduced groundwater levels below Stockton have caused the migration of saline water from the west to move eastward into the basin. In some areas below Stockton, salinity concentrations in groundwater exceed drinking water standards (SEWD 2014).

In 2014, DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) Program ranked the Eastern San Joaquin Subbasin as a high-priority groundwater basin, partially due to the basin's history of groundwater reliance for agricultural and municipal uses, seawater intrusion along a 16-mile front on the east side of the Delta, large areas of nitrate contamination, and long-term overdraft conditions (DWR 2014b). Additionally, DWR identified the Eastern San Joaquin Subbasin as a critically overdrafted basin (DWR 2016).

South San Joaquin Irrigation District

The SSJID derives its water supply from three sources: (1) surface water diverted from the Stanislaus River at Goodwin Dam, (2) groundwater, and (3) irrigation return flows from OID (SSJID 2011). Although the district receives the majority of its water from the Stanislaus River, groundwater provides important reserves that can supplement surface water during droughts (SSJID 2011). The Cities of Manteca, Ripon, and Escalon comprise approximately 10,000 acres of the SSJID service area (SSJID 2012). In 2005, SSJID began delivering treated surface water to Lathrop, Manteca, and Tracy through the South County Water Supply Program. SSJID also delivers untreated SSJID water to the City of Ripon (SSJID 2015); as of 2011, Ripon used these deliveries exclusively for groundwater recharge (SSJID 2011). The cities use groundwater to meet much of their demands, and some district growers use groundwater as a regular source for irrigation water. SSJID has leased private wells during droughts to augment water supplies to farmers, which can help to minimize cuts to city water supplies (SSJID 2011).

Groundwater recharge within the SSJID service area consists of seepage from SSJID canals and reservoirs and deep percolation of precipitation and applied irrigation water. On average, total recharge for 1994-2008 is estimated to be approximately 97 TAF/y with 52 percent of recharge originating from canal seepage and 48 percent originating from deep percolation of applied water (SSJID 2012). However, even with recharge efforts, groundwater levels continue to decline east of Stockton and north of SSJID's service area where surface water supplies are limited. Groundwater levels in that area have declined to such an extent that groundwater flow under SSJID flows northerly rather than to the west (SSJID 2015). Declining groundwater levels continued during the recent drought; between Spring 2014 and Spring 2015, groundwater levels declined in 23 wells (of 29 wells with adequate groundwater level monitoring data to allow determination of groundwater level trends) in SSJID's service area. Of the remaining 6 wells, 4 wells showed localized increases in groundwater levels and 2 wells had no change in groundwater levels (SJCFCWD 2015).

Groundwater pumped for irrigation use in SSJID is generally of good quality. SSJID monitors 28 production wells for EC using permanently installed sensors. The San Joaquin County Flood Control and Water Conservation District (SJCFCWD) conducts annual groundwater quality monitoring in 26 wells in San Joaquin County, including within the district's service area. Monitored parameters include TDS, turbidity, chloride, and EC (SSJID 2012).

Oakdale Irrigation District

OID overlies two groundwater subbasins; 43 percent (23,000 irrigated acres) overlies the Eastern San Joaquin Subbasin (OID 2012; Table 9-6) and 57 percent of OID's service area (31,000 irrigated acres) overlies the Modesto Subbasin. OID is described in the Modesto Subbasin section below.

Stockton East Water District

SEWD provides surface water for agricultural and urban uses and for groundwater recharge (SEWD 2014). SEWD has a number of surface water supply contracts with various entities; it can receive up to 40 TAF/y from New Hogan Reservoir, with an additional 27 TAF/y of New Hogan Reservoir water that is not used by Calaveras County Water District (NSJCGBA 2004). SEWD also has a contract with the U.S. Bureau of Reclamation (USBR) to receive 75 TAF/y from New Melones Reservoir through the Central Valley Project (CVP) (SEWD 2011a). However, during dry years, water delivery amounts may vary depending upon USBR water allocations. In the past, SEWD contracted with SSJID and OID to receive up to 30 TAF/y from the Stanislaus River. The agreement ended in 2009 but was extended beyond 2010 and may be renewed pending further studies (SEWD 2014). As of 2011, SEWD had two wells that are only used for emergency and dry year supply (SEWD 2011b). In critically dry years, SEWD contracts with farmers along their pipeline to pump groundwater to supply the treatment plant (SEWD 2011b).

SEWD delivers a minimum of 20 TAF/y of treated surface water to the City of Stockton, California Water Service Company, and San Joaquin County. The volume delivered to each retailer is based on the percentage of total groundwater and surface water used in each retailer's area during the previous year, which is updated every year. As of 2010, SEWD has 178 agricultural customers. Based on the 2010 SEWD water inventory, 127,575 AF of water was needed for crop irrigation. Based on actual agricultural water sales, 23,116 AF of surface water was provided by SEWD to agricultural customers, and 117,424 AF of private groundwater[10] was used for agricultural irrigation (SEWD 2014).

Measurements over the past 40 years show a fairly continuous decline in groundwater levels in the eastern San Joaquin County. As a result of groundwater pumping over many decades, a cone of depression exists east of the Stockton urban area (Figure 9-3). Groundwater levels and the extent of the overdraft issues in SEWD's service area have historically fluctuated depending on surface water availability and the district's reliance on groundwater. Water table levels in the southern and eastern areas of Stockton generally rose more than 50 ft during an 8-year period (1977–1985). Groundwater levels in the Stockton urban area and SEWD service area also rose after the 1987–1994 drought as surface water once again became more available and groundwater dependence declined. By 1999, the water table in the Stockton area was higher than the level recorded 20 years prior, reversing a downward trend that had taken place for many years as a result of pumping by various users (SEWD 2011b). SEWD has continued a conjunctive use management approach; between 2011 and 2014, SEWD pumped no groundwater. However, in 2015, as a result of extreme drought conditions and the 100-percent curtailment of water supply from New Melones Reservoir, SEWD resumed pumping groundwater (SEWD 2016). Due to resumed pumping, between Spring 2014 and Spring 2015, groundwater levels declined in 56 wells (of 69 wells with adequate groundwater level monitoring data to allow determination of groundwater level trends) in SEWD's service area. Of the remaining 13 wells, 9 wells showed localized increases in groundwater levels and 4 wells had no change in groundwater levels (SJCFCWD 2015).

Central San Joaquin Water Conservation District

The CSJWCD includes approximately 65,200 acres, of which approximately 48,000 acres are irrigated (Table 9-6); 670 acres of the districts total acreage are within the sphere of influence for the City of Stockton (NSJCGBA 2004). Historically, CSJWCD relied substantially on groundwater pumping for irrigation. CSJWCD is now contracted with USBR to receive up to 80 TAF/y of surface water from the Stanislaus River. However, during dry years, water delivery amounts may vary depending upon USBR water allocations, and the total contracted amount has never been fully delivered. Irrigation facilities have been installed and are operated by individual landowners through a surface water incentive program sponsored by the CSJWCD to mitigate declining groundwater levels in the area. SSJID and OID have occasionally made water available to CSJWCD for irrigation. Surface water deliveries from the New Melones Conveyance System allowed groundwater levels to increase by as much as 15 ft in some localized areas within the CSJWCD service area (NSJCGBA 2004). However, more recently groundwater levels have declined; between Spring 2014 and Spring 2015, groundwater levels declined in 36 wells (of 37 wells with adequate groundwater level monitoring data to allow determination of groundwater level trends) in CSJWCD's service area. The remaining well had no change in groundwater levels (SJCFCWD 2015).

Communities

The Eastern San Joaquin Subbasin has multiple communities and water purveyors that do not have water supply contracts with the irrigation districts discussed above or are located outside the

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[10] SEWD does not sell groundwater but does quantify its use.

irrigation district service areas. The Cities of Lodi, Stockton, Lathrop, Manteca, and Ripon and Escalon rely solely or partially on groundwater to meet their needs (City of Ripon 2004; NSJCGBA 2004; San Joaquin County 2009). See Chapter 13, *Service Providers*, for additional information about municipal water use in the Eastern San Joaquin Subbasin.

Modesto Subbasin

There are approximately 116,000 acres of irrigated land in the Modesto Subbasin; 77 percent of these acres potentially being supplied with surface water from OID or MID (Table 9-5). The subbasin's estimated minimum total agricultural and municipal groundwater pumping is 187 TAF/y (Table 9-6).

Net groundwater overdraft for a portion of the subbasin has been estimated to be between 11 and 15 TAF/y (Table 9-4). DWR Bulletin 118 indicates groundwater levels in this subbasin decreased approximately 0.5 foot/year between 1970 and 2000 (DWR 2003c). Between 2005 and 2010, the largest decreases in groundwater elevation occurred in the eastern portion of this subbasin in the region not irrigated with surface water (Figure 9-4). Groundwater recharge is primarily from deep percolation of applied irrigation water and canal seepage from MID and OID facilities (STRGSA 1995, MID 2015). Seepage from Modesto Reservoir is also a significant contributor, contributing an estimated 24 TAF/y (MID 2015). Recharge on a lesser basis occurs from the subsurface flows originating from the eastern foothills and mountains, infiltration from minor streams, and percolation of direct precipitation.

In 2014, DWR's CASGEM Program ranked the Modesto Subbasin as a high priority groundwater basin, partially due to the basin's history of groundwater reliance for agricultural and municipal use, and water quality degradation due to industrial and agricultural practices (DWR 2014c).

Oakdale Irrigation District

OID overlies two groundwater subbasins; 57 percent of OID's service area (31,000 irrigated acres) overlies the Modesto Subbasin, with the other 43 percent (23,000 irrigated acres) overlies the Eastern San Joaquin Subbasin (OID 2012; Table 9-6). More than 95 percent of the water served by OID is surface water diverted from the Stanislaus River at Goodwin Dam into the Joint Supply Canal and the South Main Canal (USBR and SJRGA 1999). During dry periods when surface water supplies are limited, surface water is supplemented by groundwater pumping from 25 OID wells, with a combined maximum annual production capacity of approximately 38 TAF/y (OID 2012). Annual well production ranges between 1.5 and 16 TAF/y because wells are not operated continuously (OID 2012). Most private wells in the district are for small farm and domestic use (STRGBA 2005).

Groundwater recharge within OID consists of seepage from OID canals and deep percolation of precipitation and applied irrigation water. Estimates of recharge were derived from the groundwater balance analysis; average estimated recharge for all of OID was 12 TAF/y from drainage canals, 36 TAF/y from irrigation canals, 24 TAF/y from infiltration of applied water (to irrigated land), and 15 TAF/y from infiltration of precipitation. Because OID contributes to surface water recharge of the aquifer, groundwater levels in the portions of the Eastern San Joaquin Subbasin underlying the OID service area have decreased much less than groundwater levels than the rest of the subbasin (OID 2012).

Modesto Irrigation District

MID delivers water to approximately 59,000 acres of land (Table 9-6). MID has approximately 90 groundwater wells that maintain water levels below the root zone (i.e., drainage) in the western portion of the district. MID also supplements irrigation supplies from New Don Pedro Reservoir with groundwater when surface water is limited (MID 2012). Groundwater use in the MID service area varies year-to-year, typically increasing during drought years (STRGBA 2005). As of 2016, MID only pumps and delivers groundwater to supplement water supplies to agricultural customers and does not pump nor deliver groundwater supply to urban suppliers (City of Modesto and MID 2011, City of Modesto and MID 2016). The City of Modesto satisfies approximately half of its demand with MID surface water and half with groundwater from its own wells and recharges approximately 20 TAF/y through its 11,000 dry wells (City of Modesto and MID 2011; MID 2012).

Most of the groundwater recharge within the subbasin is the result of deep percolation of applied surface water to agricultural lands, seepage from canals and reservoirs, and deep percolation of precipitation and urban storm runoff. In recent years, MID has increased recharge activities; in 2009, total groundwater recharge was estimated at approximately 81 TAF, which increased to 152 TAF in 2012 (MID 2012; MID 2015). The majority of recharge comes from MID irrigation water; in 2009, total groundwater recharged by MID irrigation water is estimated to be 58 TAF/y (MID 2012), which increased to 108.5 TAF in 2012 (MID 2015). Additionally, approximately 91 percent of MID canals are concrete-lined, resulting in a relatively small amount of canal seepage (MID 2015).

Communities

The Modesto Subbasin has multiple communities and water purveyors that do not have water supply contracts with the irrigation districts discussed above or are located outside of the irrigation district service areas. The Cities of Oakdale and Riverbank and smaller communities in Stanislaus County generally rely solely on groundwater to meet their needs (City of Oakdale 2009; STRGBA 2005). See Chapter 13, *Service Providers*, for additional information about municipal water use in the Modesto Subbasin.

Turlock Subbasin

There are approximately 269,000 acres of irrigated land in the Turlock Subbasin; 56 percent of these acres potentially being supplied with surface water from TID or a small portion from Merced ID (Tables 9-5 and 9-6). Between 1997 and 2006, total agricultural and municipal groundwater pumping in this subbasin was approximately 457 TAF/y (TGBA 2008). The subbasin’s estimated minimum total agricultural and municipal groundwater pumping is 498 TAF/y (Table 9-6).

Groundwater recharge sources include irrigation of crops and landscape vegetation, precipitation, percolation from the Tuolumne and Merced Rivers, seepage from irrigation canals and Turlock Lake, groundwater recharge programs, percolation from Sierra Nevada foothill streams, and upward seepage from deeper aquifers (below the Corcoran Clay) (TID 2008). The upper reaches of the Tuolumne and Merced Rivers provide infiltration recharge (i.e., losing rivers), but the aquifer contributes water (through springs and seeps) to the lower reaches of the Tuolumne and Merced Rivers (i.e., gaining rivers) (TID 2008). Recharge from croplands is estimated to be 375 TAF/y, while recharge from landscaping within urban areas is estimated to be 18 TAF/y (TGBA 2008).

Net groundwater overdraft for the subbasin is estimated to be between 9 and 85 TAF/y (Table 9-4). Between 1970 and 2000, groundwater levels in the Turlock Subbasin declined approximately 7 ft (or 0.25 ft/y), with greater declines in the eastern portion of the subbasin after 1982 (DWR 2003d). There is a fairly large cone of depression in the eastern portion of the Turlock Subbasin below land primarily irrigated with groundwater. In 2010, groundwater elevations were at a high of 100 ft above MSL in the middle portion of the subbasin, but dropped down to 25 ft above MSL in the eastern portion of the subbasin (Figure 9-3). Between 2005 and 2010, groundwater elevations in this eastern portion of the subbasin decreased by up to 30 ft (Figure 9-4).

In 2014, DWR's CASGEM Program ranked the Turlock Subbasin as a high priority groundwater basin, partially due to the basin's history of groundwater reliance for agricultural and municipal use, and overdraft issues (DWR 2014d).

Turlock Irrigation District

TID utilizes a combination of surface water and groundwater to supply water to its agricultural users (TGBA 2008). Agricultural land within the TID service area is primarily irrigated with surface water, which is also a main source of recharge within the Turlock Subbasin (City of Modesto 2008). TID pumps approximately 65 TAF/y for drainage in the western portion of the district, and "rents" wells from growers during drought years (e.g., 1977, 1997–1992) (TGBA 2008). In addition, some growers pump groundwater to supplement their surface water allotments, while others use groundwater to meet their entire irrigation requirement. The minimum pumping within the district for drainage and irrigation is estimated to be 100 TAF/y, while the maximum groundwater pumping within the district is estimated to be 275 TAF/y (TGBA 2008).

Total recharge within the service area is estimated to average 238 TAF/y, with deep percolation of applied water and of precipitation averaging 156 TAF/y and 44 TAF/y (3.5 inches), respectively. Within the district, average groundwater pumping is estimated to be approximately 103 TAF/y (TID 2012).

Merced Irrigation District

Merced ID overlies three groundwater subbasins: 5 percent overlies the Turlock Subbasin, 86 percent overlies the Merced Subbasin, and the remaining 9 percent overlies the portion of the Chowchilla Subbasin that is analyzed with the Merced Subbasin as the "Extended Merced Subbasin" (Table 9-6). Merced ID is described in more detail under the Merced Subbasin section below.

Eastside Water District and Ballico-Cortez Water District

EWD and BCWD depend on groundwater from the Turlock Subbasin for water supply to irrigate approximately 54,000 acres and 67,000 acres, respectively (TID 2008). All irrigation facilities within the EWD and BCWD service areas are privately owned and operated. Growers have installed irrigation supply wells, as needed, to irrigated their crops (TGBA 2008). Growers pumped an estimated 180 TAF/y between 1997 and 2006 (City of Modesto 2008). With the exception of those properties adjacent to the rivers that have riparian water rights and can utilize surface water for irrigation, these districts rely upon groundwater for their entire water supply (City of Modesto 2008). The only other source of water supply is a very limited amount of surface water purchased in wet years from the TID and Merced ID canals adjacent to EWD. EWD does not own or operate water supply infrastructure (TGBA 2008). Groundwater levels in the vicinity have dropped dramatically since the mid-1950s. Groundwater levels within the EWD service area are declining approximately 2 ft/year, creating an average annual deficit of approximately 80 TAF (ESRWMP 2013).

Other Growers

Between 1997 and 2006, growers outside TID, EWD, and BCWD (i.e., located along the river margins and east of the EWD and BCWD service areas) pumped an average of 115 TAF/y (ESRWMP 2013). As agricultural development continues in these areas, dependence upon groundwater will likely increase (City of Modesto 2008).

Communities

The Turlock Subbasin has multiple communities and water purveyors that do not have water supply contracts with the irrigation districts discussed above or are located outside the irrigation district service areas. The Cities of Ceres, Delhi, Denair, Hickman, Hilmar, Hughson, Keyes, and Turlock generally rely solely on groundwater to meet their needs (TGBA 2008). Between 1997 and 2016, average municipal pumping was 44 TAF/y (TID 2008), somewhat less than DWR's estimated 65 TAF/y (DWR 2003d, Table 9-6). See Chapter 13, *Service Providers*, for additional information about municipal water use in the Turlock Subbasin.

Merced Subbasin

There are approximately 269,000 acres of irrigated land in the Merced Subbasin; 32 percent of these acres are potentially supplied with surface water from Merced ID (Table 9-5). The subbasin's natural recharge is 47 TAF/y, and approximately 243 TAF/y of applied water recharge occurs in the subbasin (Merced ID 2013a). Recharge and conservation projects provided an annual in-lieu recharge (i.e., replacing pumping with surface water) of approximately 60 TAF/y (MAGPI 2008). The subbasin's estimated minimum total agricultural and municipal groundwater pumping is 642 TAF/y (Table 9-6).

Long-term well level records show that groundwater elevations have declined with time throughout most of the subbasin; between 1980 and 2008, average levels declined 14 ft (MAGPI 2008). This is approximately half of the decline of 1 ft/y described above for 1970–2000 (DWR 2003e). Overdraft estimates for the subbasin range between 20 and 44 TAF/y (Table 9-4), with more severe water level declines in the eastern portion of the subbasin (DWR 2003e). Well data for 2010 indicate gradually increasing groundwater elevations from the SJR to the mountains and from north to south, which is what would be expected based on the effect of river elevation and topography on groundwater elevations (Figure 9-3). However, the southeast corner of the Merced Subbasin, an area with little surface water supply, has a cone of depression with groundwater elevations close to sea level (Figure 9-3).

In 2014, DWR's CASGEM Program ranked the Merced Subbasin as a high priority groundwater basin, partially due to the basin's history of groundwater reliance for agricultural and municipal use, and known overdraft and water quality degradation issues (DWR 2014e). Additionally, the CASGEM Program ranked the Chowchilla Subbasin (which, combined with the Merced Subbasin, comprises the Extended Merced Subbasin) as a high priority basin, partially due to the basin's history of groundwater reliance for agricultural use, and known overdraft, subsidence, and water quality degradation issues (DWR 2014f). In 2016, DWR identified both the Merced and Chowchilla Subbasins as critically overdrafted basins (DWR 2016).

Merced Irrigation District

As noted above, Merced ID overlies three groundwater subbasins; 5 percent of Merced ID's service area overlies the Turlock Subbasin, 9 percent overlies the Chowchilla Subbasin (or Extended Merced Subbasin), and the remaining 86 percent of Merced ID lands are located in the Merced Subbasin (Table 9-6). The portion of Merced ID that overlies the Chowchilla Subbasin is land that originally comprised the El Nido Irrigation District, which was incorporated into Merced ID in 2005 (Merced ID 2013a). Merced ID primarily uses surface water diversions from the Merced River to supply irrigation water to its service area. Merced ID supplements its surface water supply with groundwater for irrigation. The extent of Merced ID's groundwater supplementation varies year-to-year, depending on the availability of surface water (TGBA 2008). Merced ID owns, operates, and maintains 235 groundwater wells, of which 198 were operational in 2013. Some wells are operated to drain high water levels in the western part of the district's service area. However, the majority of these wells are left on standby to be operated for irrigation during years of surface water shortages. Merced ID's service area contains 1,764 acres of high ground (i.e., land higher than nearby canals) that are served by 8 TAF/y of groundwater pumping, although pumping has been reduced to 4 TAF/y with booster pumps that supply surface water from the canals (Merced ID 2013a). Between 2000 and 2008, Merced ID average groundwater pumping was 31 TAF/y, and active Merced ID customers pumped 32 TAF/y (Merced ID 2013a). During this period, it is estimated that private customers pumped between zero and 153 TAF/y (Merced ID 2013a).

Between 2000 and 2008, groundwater recharge within the Merced ID service area was estimated as deep percolation of applied water (60 TAF/y), canal seepage (98 TAF/y) and in-lieu recharge (32 TAF/y). Therefore, the total annual average estimated recharge from the Merced ID was 190 TAF/y (Merced ID 2013a). Merced ID delivers some water to Madera County, in the Chowchilla Subbasin, and other surrounding areas, such as Stevinson Irrigation District, the Merced Wildlife Refuge, and the City of Merced.

Communities

The Merced Subbasin has multiple communities and water purveyors that do not have water supply contracts with the irrigation district discussed above or are located outside the irrigation districts' service areas. The Cities of Atwater, Livingston, and Merced; the Black Rascal Mutual Water Company; Le Grand and Planada Community Service District; the Meadowbrook Water Company; and the Winton Water and Sanitary District generally rely solely on groundwater to meet their needs (MAGPI 2008). In 2007, total municipal pumping was estimated to be 50 TAF/y (Merced ID 2013a). The City of Merced receives the majority of its water supply from groundwater. However, the city is evaluating long-term and short-term water transfers and other options to obtain surface water and augment its groundwater supply (Merced ID 2013a). See Chapter 13, *Service Providers*, for additional information about municipal water use in the Eastern San Joaquin Subbasin.

9.2.3 Extended Plan Area

The extended plan area has no designated groundwater basins with the exception of the Yosemite Basin in Yosemite National Park in Mariposa County. This lack of designated groundwater basins is primarily due to the generally shallow-to-bedrock geology. Groundwater occurs in fractures in the bedrock and the local and regional rock fracture system characteristics influence water levels and well yields. Consequently, groundwater areas are often small, localized, and isolated from each other (DWR 2003h).

9.2.4 Southern Delta

Agricultural users in the southern Delta apply surface water to irrigate their crops. Some of the agricultural users apply additional surface water to reduce the salts in the root zone of the crops. However, the water sources in the southern Delta are primarily surface water coming from the southern Delta channels and not from groundwater pumping. Therefore, groundwater resources in the southern Delta are not discussed in this chapter.

9.3 Regulatory Background

9.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to groundwater resources are described briefly below but relate principally to preventing the discharge of pollutants into waters of the United States and protecting public health by regulating drinking water. Additional information on both of the federal statutes listed below is found in Chapter 13, *Service Providers*.

Clean Water Act

The federal Clean Water Act (33 U.S.C., §§ 1251–1376) places primary responsibility for developing water quality standards on the states. The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and gives USEPA the authority to implement pollution control programs, such as setting wastewater standards for industry. The statute employs a variety of regulatory and non-regulatory tools to reduce pollutant discharges into waters of the United States, finance municipal wastewater treatment facilities, and manage polluted runoff.

Safe Drinking Water Act

The federal Safe Drinking Water Act (42 U.S.C., § 300 et seq.) protects public health by regulating the nation's public drinking water supply. In addition to drinking water itself, the act requires the protection of its sources, such as rivers, lakes, reservoirs, springs, and groundwater wells. The act authorizes the USEPA to set national health-based standards for drinking water, such as MCLs, to protect against contaminants that may adversely affect public health. In California, as of July 1, 2014, the State Water Board's Division of Drinking Water implements the Safe Drinking Water Act.

9.3.2 State

Relevant state programs, policies, plans, or regulations related to groundwater resources are described below. Until SGMA became effective in January 2015, the State regulated groundwater in a relatively minor capacity and considered groundwater management to be a local responsibility.

Sustainable Groundwater Management Act

On January 1, 2015, it became California state policy (Wat. Code, § 113) that "groundwater resources be managed sustainably for long-term reliability and multiple economic, social, and environmental benefits for current and future beneficial uses" and that sustainable groundwater management "is best achieved locally through the development, implementation, and updating of plans and programs based on the best available science." SGMA (Wat. Code, § 10720 et seq.) provides the framework to implement this policy by requiring that local agencies in high- and medium-priority basins[11] (DWR 2014a) form GSAs by June 30, 2017 that will develop and implement GSPs that achieve sustainable groundwater management within 20 years.

SGMA defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the [50 year] planning and implementation horizon without causing undesirable results." Undesirable results are defined as any of the following effects.

- Chronic lowering of groundwater levels (not including overdraft during a drought if a basin is otherwise managed).
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Depletions of interconnected surface water that have significant and unreasonable adverse effects on beneficial uses of the surface water.

(Wat. Code, § 10721, subd. (x).) SGMA requires that critically overdrafted high- and medium-priority basins adopt GSPs by January 31, 2020 (DWR 2016). In the study area, that deadline applies to the Eastern San Joaquin, Merced, and Chowchilla Subbasins, which are listed as high-priority and critically overdrafted. All other high- or medium-priority basins must adopt GSPs by January 31, 2022. In the study area, this includes the Modesto and Turlock Subbasins, which are listed as high-priority basins.

If local agencies are unwilling or unable to manage their groundwater resources, SGMA authorizes the State Water Board to step in to protect a groundwater basin in limited circumstances: (1) if no agency has opted by the June 30, 2017 to serve as a GSA for a basin,[12] (2) when a GSA does not complete a GSP by the relevant deadline (2020 or 2022), or (3) when the GSP is inadequate or the GSP is not being implemented in a manner that is likely to achieve the plan's sustainability goal(s), and the basin is either in a condition of long-term overdraft or, after January 31, 2025, the State Water Board determines that the basin is in a condition where groundwater extractions result in significant depletions of interconnected surface waters.

SGMA is intended to promote coordinated management of a groundwater basins through GSA formation. While it is too early to know how GSAs will approach sustainable groundwater management, and GSPs will vary in terms of groundwater management components and implementation methods, sustainably management is a legal obligation. SGMA requires

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[11] 127 of California's 515 alluvial groundwater basins, which account for 96 percent of California's annual groundwater pumping, were identified as high- or medium-priority. Prioritization factors include, but are not limited to, the level of population overlying the basin or subbasin, the projected rate of population growth for the basin or subbasin, the number of public supply wells dependent on the basin or subbasin, the irrigated acreage overlying the basin or subbasin, and the degree of reliance on groundwater. (Wat. Code, § 10933, subd. (b).)

[12] In addition, if an agency fails to form a GSA by the deadline, local groundwater users must begin reporting groundwater use to the State Water Board.

consideration of all stakeholder interests within their regions, including beneficial users of water, environmental interests, disadvantaged communities, tribes, and others. SGMA also includes provisions to protect water rights, including stating that nothing in SGMA "determines or alters surface water rights or groundwater rights under common law or any provisions of law that determines or grants surface water rights." However, between SGMA's enactment on January 1, 2015, and until the time that a GSP or its functional equivalent is adopted, SGMA prohibits groundwater extractions from being used as evidence of, or to establish or defend against, any claim of prescription. (Wat. Code, § 10720.5.) As a practical matter this means that pumping more groundwater after enactment of the Act and prior to adoption of the GSP will not later provide the basis for a claim that a groundwater right is larger than the right that existed on December 31, 2014.

Porter-Cologne Water Quality Control Act

As discussed in Chapter 1, *Introduction*, and Chapter 5, *Surface Hydrology and Water Quality*, the Porter-Cologne Water Quality Control Act is California's primary authority for regulating surface and groundwater quality. (Wat. Code, § 13000 et seq.) Under the Porter-Cologne Act, the state is divided into nine regions, and a Regional Water Board has the primary responsibility for protecting water quality within each region. The State Water Board oversees the Regional Water Boards' implementation of the Porter-Cologne Act and, together with the Regional Water Boards, implements the federal Clean Water Act. The Regional Water Boards have primary responsibility for the formulation and adoption of water quality control plans for their respective regions, subject to State Water Board and USEPA approval. The State Water Board may also adopt water quality control plans, which will supersede regional water quality control plans for the same waters to the extent of any conflict.

The SJR Basin falls within the jurisdiction of the Central Valley Regional Water Quality Control Board (Central Valley Water Board). The *Central Valley Board's Water Basin Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan) specifies that all groundwater in the Region are considered as suitable or potentially suitable, at a minimum, for the following beneficial uses (Central Valley Water Board 2016).

- Municipal and domestic water supply (MUN)
- Agricultural supply (AGR)
- Industrial service supply (IND)
- Industrial process supply (PRO)

The Basin Plan provides certain exceptions for when these beneficial uses can be de-designated (e.g., when there is contamination or pollution in the groundwater that cannot reasonably be treated using either best management practices or best economically achievably treatment practices).

Groundwater Quality Protection Strategy for the Central Valley Region

In 2008, the Central Valley Water Board adopted Resolution No. R5-2008-0181 in Support of Developing a Groundwater Strategy for the Central Valley Region. In 2010, the Central Valley Water Board adopted Resolution No. R5-2010-0095 the Groundwater Quality Protection Strategy for the Central Valley Region, "a Roadmap", a long-term strategy that identifies high-priority activities. The roadmap recognizes the Central Valley Water Board's core responsibilities and existing commitments, and builds on existing processes. The roadmap is intended to be an overarching framework for long-range planning and is not a new regulatory program (Central Valley Water Board 2012).

California Statewide Groundwater Elevation Monitoring Program

The CASGEM program (Wat. Code, § 10920 et seq.) established a permanent, locally-managed program of regular and systematic monitoring and reporting in all of California's alluvial groundwater basins. The program relies on the many established local long-term groundwater monitoring and management programs and designates specific monitoring entities to report groundwater elevation data to DWR, which makes it available to the public. There is at least one CASGEM monitoring entity in each of the four subbasins underlying the study area (DWR 2015c). Monitoring entities began submitting CASGEM groundwater elevation data to DWR in January, 2012.

Groundwater Ambient Monitoring and Assessment Program

The GAMA is a comprehensive groundwater quality monitoring program based on interagency collaboration between the State Water Board, Regional Water Boards, DWR, Department of Pesticide Regulations, U.S. Geological Survey, and Lawrence Livermore National Laboratory (LLNL), and cooperation with local water agencies and well owners. GAMA is described in greater detail in Chapter 13, *Service Providers.*

Other State Authorities

State water law includes other more general authorities for the protection of groundwater resources including, but not limited to, the following.

Waste and Unreasonable Use

California Constitution Article X, Section 2 and California Water Code Section 100 prohibit the waste, unreasonable use, unreasonable method of use, and unreasonable method of diversion of water. The constitutional doctrine of reasonable use applies to all water users, regardless of basis of water right, serving as a limitation on every water right and every method of diversion (Peabody v. Vallejo [1935] 2 Cal.2d 351, 367, 372). California Water Code Section 275 directs the State Water Board (and DWR) to take all appropriate proceedings or actions to prevent waste or violations of the reasonable use standard. Thus, the State Water Board may initiate proceedings, either administratively or in court, to prevent the waste and unreasonable use of water.

The State Water Board also has authority to address the waste, unreasonable use, unreasonable method of use, and unreasonable method of diversion of water through quasi-legislative action. Questions of waste, unreasonable use, and unreasonable methods of use or diversion are factual and are determined according to the circumstances of a particular situation, limiting the utility of the regulatory process to only those cases where waste or unreasonableness can be clearly identified and prevented by an appropriately tailored regulatory response. Due to the highly complex nature of findings and proceedings, the State Water Board has only made the findings required to proscribe waste, unreasonable use, and unreasonable method of use or diversion through regulation twice. (Cal Code Regs., tit. 23, §§ 735, 862.)

Groundwater Adjudications

An adjudication is an action filed in Superior Court by one or more groundwater pumpers to comprehensively determine groundwater rights in a specified area. Through adjudication, the courts can assign specific rights to water users and can compel the cooperation of those who might otherwise refuse to limit their pumping of groundwater. The court retains continuing jurisdiction over the adjudicated area and typically appoints a watermaster to ensure pumping conforms to the adjudication's limits. In 2015, the Legislature passed Assembly Bill (AB) 1390 (Alejo), a statute to streamline the methods and procedures for groundwater adjudications (Code of Civil Proc., § 830 et seq.), and Senate Bill (SB) 226 (Pavley), a statute adding a new chapter to SGMA that requires adjudications in groundwater basins subject to SGMA be consistent with SGMA. (Wat. Code, § 10720.1 et seq.)

In addition, the State Water Board has the authority to file an adjudicative action to restrict groundwater pumping, or to impose a physical solution, or both, where necessary to protect groundwater quality. (Wat. Code, §§ 2100-2102.)

Area of Origin Limitations

The State Water Board has permitting authority over subterranean streams flowing in known and definite channels. (Wat. Code, § 1200.) Groundwater not flowing in a subterranean stream, such as water percolating through a groundwater basin, is not subject to the State Water Board's permitting jurisdiction. However, the State Water Board may exercise its authority under the doctrines of reasonable use and the public trust to address diversions of surface water or groundwater that reduce instream flows and adversely affect fish, wildlife, or other instream beneficial uses.

Pumping groundwater for export is prohibited "within the combined Sacramento and Delta-Central Sierra Basins…unless the pumping is in compliance with a groundwater management plan that is adopted by [county] ordinance." (Wat. Code, § 1220.) The statute enables, but does not require, the board of supervisors of any county within any part of the combined Sacramento and Delta-Central Sierra Basin to adopt GWMPs. GWMPs have been adopted in some counties, as described below.

9.3.3 Regional or Local

Relevant regional or local programs, policies, or regulations related to groundwater resources are described below. Although local policies, plans, and regulations are not binding on the State of California, below is a description of relevant ones.

Agricultural Water Management Plans

California Water Code Section 10800 et seq. requires an agricultural water supplier with greater than 25,000 irrigated acres to adopt and implement an AWMP to efficiently manage water resources within its service area. Several irrigation districts have prepared AWMPs that identify methods for dealing with water supply shortages; including reliance on groundwater. 2012 AWMPs that are relevant to the irrigation districts and four subbasins are summarized in Table 9-7. The AWMPs were reviewed for how they allocate water and their policies for water shortages; Table 9-8 compares the methods used in the AWMPs for dealing with surface water shortages.

In April 2015, Executive Order (EO) B-29-15 lowered the irrigated acreage requirement to 10,000 irrigated acres. Those agricultural water suppliers that supply water to 10,000 to

25,000 acres of irrigated lands are required to develop AWMPs and submit the plans to DWR by July 1, 2016 (these plans are called the 2015 AWMPs). EO B-29-15 also requires that 2015 AWMPs include a detailed drought management plan that describes the actions and measures the supplier will take to manage water demand during drought

Table 9-7. Relevant Agricultural Water Management Plans

Relevant Groundwater Subbasin	Entity/Entities	Document Title	AWMP Report Date	Adoption Date	County
Modesto	Modesto ID	Modesto ID AWMP for 2012	12/2012	12/2012	Stanislaus
Eastern San Joaquin, Modesto	Oakdale ID	Oakdale ID 2012 AWMP	12/2012	12/2012	San Joaquin, Stanislaus
Eastern San Joaquin	South San Joaquin ID	South San Joaquin ID 2012 AWMP	12/2012	12/2012	San Joaquin
Turlock	Turlock ID	Turlock ID 2012 AWMP	12/2012	12/2012	Stanislaus, Merced
Merced	Merced ID	Merced ID AWMP	9/2013	9/2013	Merced
Eastern San Joaquin	Stockton East WD	Stockton East WD Water Management Plan	1/2014	1/2014	San Joaquin

Source: Merced ID 2013a; MID 2012; OID 2012; SEWD 2014; SSJID 2012; TID 2012.

AWMP = agricultural water management plan
ID = irrigation district
WD = water district

Table 9-8. Irrigation District Methods for Dealing with Surface Water Shortages

Irrigation District	Conjunctive Use	Reduction in Surface Water Allotments	Allowable Internal Transfers	Groundwater Used for Permanent Crops	Holds Carryover Surface Water for Crops	All Shortages Managed with Groundwater	Fair and Equitable Distribution	USBR Responsible for Shortages
SSJID	X	X	X	NA	NA	NA	X	X
OID	X	X	X	X	NA	NA	X	X
SEWD	X	X	NA	NA	NA	NA	NA	X
TID	X	X	X	X	X	NA	NA	NA
MID	X	X	NA	X	X	NA	NA	NA
Merced ID	X	X	NA	X	C	X	X	NA

Sources: SSJID 2011; SEWD 2014; City of Stockton 2011; TID 2012; OID 2012; MID 2012; EWD 2003; Merced ID 2013a; City of Merced 2001.

Merced ID = Merced Irrigation District
MID = Modesto Irrigation District
NA = Not Applicable
OID = Oakdale Irrigation District
SSJID = South San Joaquin Irrigation District
SEWD = Stockton East Water District
TID = Turlock Irrigation District
USBR = U.S. Bureau of Reclamation

Groundwater Management Plans

Prior to SGMA's passage, groundwater management planning was a voluntary activity by local agencies in accordance with either AB 3030 (Costa), which was passed in 1992, or SB 1938 (Machado), which was passed in 2008 (consequently, those types of plans are commonly referred to as "AB 3030 plans" or "SB 1938 plans"). Both types of plans are discussed in more detail below. Under SGMA, an AB 3030 or SB 1938 plan that existed as of January 1, 2015 (the day SGMA took effect) can be submitted by January 1, 2017, for review by DWR as to whether that existing plan meets SGMA's requirements and therefore is approved as an alternative to a GSP. (Wat. Code, § 10733.6.) However, most AB 3030 and SB 1938 plans to not require sustainable groundwater management such as calculating the annual safe yield of a basin, limiting groundwater pumping to the safe yield, and enforcing the limitation. Unless approved as an alternative, AB 3030 and SB 1938 plans that are in areas subject to SGMA remain in effect until a GSP is adopted and may not be amended. In addition, in areas subject to SGMA, no new AB 3030 or SB 1938 plans may be adopted, only GSPs. (Wat. Code, § 10750.1.)

AB 3030 (Wat. Code, § 10750 et seq.) created a systematic procedure for an existing local agency to voluntarily develop a GWMP. AB 3030 also encouraged local agencies to cooperatively manage groundwater resources within their jurisdictions and to provide a methodology for developing GWMPs for groundwater basins defined in DWR Bulletin 118. The AB 3030 GWMPs introduced 12 technical components that could be, but were not required to be, included in the plans: (1) the control of saline water intrusion; (2) identification and management of wellhead protection areas and recharge areas; (3) regulation of the migration of contaminated groundwater; (4) administration of a well abandonment and well destruction program; (5) mitigation of conditions of overdraft; (6) replenishment of groundwater extracted by water producers; (7) monitoring of groundwater levels and storage; (8) facilitating conjunctive use operations; (9) identification of well construction policies; (10) construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects; (11) development of relationships with state and federal regulatory agencies; and (12) review of land use plans and coordination with land use planning agencies to assess activities (DWR 2014d). SB 1938 modified AB 3030's approach by making the development of GWMPs mandatory for any public agency seeking State funds administered through DWR for the construction of groundwater projects. SB 1938 also established mandatory components that the plans had to include to be deemed adequate: (1) basin management objectives relating to the monitoring and management of groundwater levels within the groundwater basin; (2) groundwater quality degradation, inelastic surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin; (3) agency cooperation such that the development of the plan involved other agencies and that the plan enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin; (4) a map of the local agencies' service area that is subject to the GWMP as well as the boundary of the DWR Bulletin 118 boundary and the boundaries of other local agencies that overlie the basin in with the agency is located; and (5) monitoring protocols designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence (in basins for which subsidence has been identified as a potential problem), and flow and quality of surface water that directly affect groundwater levels or quality, or are caused by groundwater pumping in the basin (DWR 2014e). GWMP requirements were again modified by AB 359

(Huffman), which became effective in 2013. AB 359 added additional required technical components and modified several GWMP adoption procedures (DWR 2014f).

GWMPs that are relevant to the irrigation districts and four subbasins are summarized in Table 9-9. The GWMPs do not always include the entire subbasin but describe the general subbasin characteristics. GWMPs vary in terms of groundwater management components and implementation methods included. The plans generally require the protection of existing groundwater resources and identify ways to reduce groundwater pumping or increase the recharge of groundwater basins through surface water diversions.

Table 9-9. Relevant Groundwater Management Plans

Relevant Groundwater Subbasin	Entity/Entities	Document Title	GWMP Report Date	Adoption Date	County
Eastern San Joaquin	South San Joaquin ID	South San Joaquin ID GWMP	12/1994	2/1995	San Joaquin
Eastern San Joaquin	Stockton East WD	Eastern San Joaquin Groundwater Basin GWMP	9/2004	2005	San Joaquin
Eastern San Joaquin, Modesto	Oakdale ID	Integrated Regional GWMP for the Modesto Subbasin	6/2005	6/2005	San Joaquin, Stanislaus
Modesto	Modesto ID	Integrated Regional GWMP for the Modesto Subbasin	6/2005	5/2005	Stanislaus
Turlock	Eastside WD	Turlock Groundwater Basin GWMP	3/2008	1/2008	Merced, Stanislaus
Turlock	Turlock ID	Turlock Groundwater Basin GWMP	3/2008	3/2008	Stanislaus, Merced
Merced	Merced ID	Merced Groundwater Basin GWMP Update	7/2008	7/2012	Merced

Source: MAGPI 2008; NSJCGBA 2004; SSJID 1994; STRGBA 2005; TID 2008.

GWMP = groundwater management plan
ID = irrigation district
WD = water district

Integrated Regional Water Management Plans

Integrated Regional Water Management (IRWM) Planning is a collaborative stakeholder process that promotes sustainable water use. IRWM Planning identifies and implements water management efforts on a regional scale to ensure sustainable water uses, reliable water supplies, better water quality, efficient urban development, protection of agriculture, environmental stewardship, and a strong economy. IRWM plans acknowledge that regions have distinct identities and hydrologic and ecologic conditions, and that water supply reliability should be a primary water management objective to be considered in these integrated plans. IRWMPs that are relevant to the irrigation districts and four subbasins are summarized in Table 9-10.

Table 9-10. Relevant Integrated Regional Water Management Plans

Relevant Groundwater Subbasin	Entity/Entities	Document Title	IRWMP Report Date	Adoption Date	County
Merced	Merced ID	Merced IRWMP	8/2013	11/2013	Merced
Eastern San Joaquin	Central San Joaquin WCD	2014 Eastern San Joaquin IRWMP Update	6/2014	6/2016	San Joaquin
Eastern San Joaquin	South San Joaquin ID	2014 Eastern San Joaquin IRWMP Update	6/2014	6/2014	San Joaquin
Eastern San Joaquin	Stockton East WD	2014 Eastern San Joaquin IRWMP Update	6/2014	6/2014	San Joaquin

Source: ESJCGBA 2014; Merced ID 2013b.

IRWMP = integrated regional water management plan
ID = irrigation district
WCD = water conservation district
WD = water district

Urban Water Management Plans

The California Urban Water Management Planning Act (UWMPA) requires California's urban water suppliers to initiate planning strategies to ensure the appropriate level of reliability in their water service to meet the needs of the various categories of customers during normal, dry, and multiple dry years. To do this, urban water suppliers must prepare a UWMP every 5 years. UWMPs served as a resource for planners and policy makers over a 25-year planning time fame, and include information about groundwater and surface water supplies, historic and projected water use, recycled water, water use efficiency programs in a contracting water district's service area, and contingency planning for the possibility of water shortages.

2015 UWMPs (due to DWR by July 1, 2016) do not reflect new requirements for groundwater management under SGMA. However, DWR recommended that 2015 UWMPs include a discussion of current or planned activities to meet anticipated SGMA requirements (DWR 2016). 2010 UWMPs that are relevant to the irrigation districts and four subbasins are summarized in Table 9-11; 2010 UWMPs that are relevant to the urban water suppliers are summarized in Chapter 13, *Service Providers*. UWMPs vary in terms of water shortage management responses and implementation methods included.

Table 9-11. Relevant Urban Water Management Plans

Relevant Groundwater Subbasin	Entity/Entities	Document Title	UWMP Report Date	Adoption Date	County
Modesto	Modesto ID	City of Modesto and Modesto ID Joint UWMP 2010 Final	5/2011	5/2011	Stanislaus
Eastern San Joaquin	South San Joaquin ID	South San Joaquin ID 2010 UWMP	8/2011	9/2011	San Joaquin

Source: City of Modesto and MID 2011; SSJID 2011.
UWMP = urban water management plan
ID = irrigation district

Groundwater Management Ordinances

Several ordinances applicable to groundwater resources that underlie the Stanislaus, Tuolumne, and Merced Rivers and SJR have been passed. These include ordinances in Merced, San Joaquin, Stanislaus, and Tuolumne Counties. No ordinances exist or have been proposed for groundwater resources in Mariposa County. Ordinances for Merced, San Joaquin, Stanislaus, and Tuolumne Counties are discussed in the following sections.

Merced County

Merced County's groundwater management ordinance was promulgated in 2015. It requires a permit for drilling a new well, mining groundwater, and exporting groundwater outside of the county. The ordinance also requires new well owners to install a metering device to report water usage to the county (Miller 2015).

San Joaquin County

San Joaquin County's groundwater management ordinance was promulgated in 1996. It requires a permit for any groundwater exports from the Eastern San Joaquin Subbasin. Before a permit will be issued, an applicant is required to demonstrate that the proposed export will not exacerbate the existing groundwater overdraft conditions. The ordinance was developed to protect investments supporting groundwater bank development (NSJCGBA 2004).

Stanislaus County

Stanislaus County's first groundwater management ordinance was promulgated in 2013. It restricts out-of-county transfers of groundwater or pumping to replace surface water sold to buyers outside of the county (Carlson 2013). In 2014, San Joaquin County expanded their groundwater management ordinance to align the county's requirements, prohibitions, and exemptions with SGMA. It also required applicants for permits to demonstrate that new wells will not have a detrimental effect on the county's groundwater resources (SCDER 2015).

Tuolumne County

Tuolumne County's groundwater management ordinance requires a permit for exporting groundwater outside of the county (Tuolumne Utilities District 2010).

9.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on groundwater resources. It further describes the methods of analysis used to determine significance of impacts on groundwater resources. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

9.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Impacts on groundwater resources were identified as potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis as to whether the alternatives could result in the following.

- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge.
- Potentially cause subsidence as a result of groundwater depletion.

9.4.2 Methods and Approach

LSJR Alternatives

This chapter evaluates the potential groundwater impacts associated with the LSJR alternatives. Each LSJR alternative includes a February-June unimpaired flow[13] requirement (i.e., 20, 40, or 60 percent) and different methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. The sections below describe steps for processing the State Water Board's WSE model results for the groundwater analysis, methods of analysis for adaptive implementation in this chapter, and baseline results to which the LSJR alternatives are compared to determine the significance of impacts on groundwater.

Processing of WSE Model Results

Geographical Treatment of Aquifer

The impact analysis uses results from the WSE model to determine if the LSJR alternatives would result in impacts on groundwater resources by increasing groundwater pumping and reducing groundwater recharge relative to the baseline water balance for each of the four subbasins that would potentially be affected (Eastern San Joaquin, Turlock, Modesto, and Extended Merced). Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives:*

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[13] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

Methodology and Modeling Results, contains a detailed description of the groundwater analysis methods and results; a summary of the analysis is provided here. For analysis purposes, the Merced Subbasin was extended south to the Chowchilla River because the Merced ID land that was formerly the El Nido ID is in the northern part of the Chowchilla Subbasin between the Merced Subbasin and the Chowchilla River (Figure 9-1). This extension added an additional 26,000 acres to the Merced Subbasin, bringing the total area to 517,000 acres. In the analysis, the combination of the Merced Subbasin and the land between the Merced Subbasin and the Chowchilla River is called the Extended Merced Subbasin.

In order to assess the effects of the LSJR alternatives on groundwater, groundwater in the four subbasins was considered to be four separate pools of water, each with no separation between shallow and deep aquifers. In reality, water can move slowly between subbasins, and there may be differences in effects between shallow (semi-confined) and deep (confined) sections of the aquifer. To the extent that water moves between subbasins, some of the groundwater impacts could have slight effects on adjoining subbasins, which would reduce the effects within the subbasins of concern. In some areas, deeper sections of the aquifer may be separated from shallower sections by substrate with low permeability. The evaluation of groundwater effects was not separated by depth because: (1) there is some connectivity between the different depths, and (2) increased groundwater pumping would occur in both shallow and deep wells. Substrate with low permeability (e.g., the Corcoran Clay at the western side of the four subbasins of interest) might slow the interaction between deeper, confined and shallower, unconfined sections of the aquifer, but water pumped from a deeper confined section of the aquifer would eventually be replaced by water from above or from surrounding subbasins. Furthermore, within the four subbasins, there are numerous deep and shallow drinking water and agricultural wells, making it infeasible to assign increases in pumping to separate sections of the aquifer as a whole. These simplifying assumptions of separating the aquifer by subbasin and not by depth are acceptable because the purpose of the analysis is to estimate the general magnitude of the average effect of the LSJR alternatives on the subbasins, not effects at specific well locations.

Apportionment of Diversions Simulated by WSE Model

For each LSJR alternative, the WSE model produced estimates of the amount of diversions that were available from each river. These results were post-processed within the WSE model and in a groundwater analysis spreadsheet to estimate groundwater effects. As part of this post-processing, the diversions for each river were partitioned between different types of deliveries and losses.

In the first step of post-processing, the following volumes, assumed not to be subject to a water shortage, were subtracted from the total diversions for each river to calculate how much water remained.

- Municipal and industrial water supplies – volumes include Stanislaus River water for DeGroot Water Treatment Plant (for the Cities of Lathrop, Manteca, and Tracy through the South County Water Supply Program) and Tuolumne River water for the City of Modesto. These municipal and industrial water suppliers use a relatively small portion of the total surface water diversion from the Stanislaus and Tuolumne Rivers. (The model assumes that municipal water providers would not experience a reduction in surface water supply; this assumption is only used for calculating groundwater impacts and agricultural impacts. Potential impacts on municipal and industrial water users are evaluated in Chapter 13, *Service Providers*.)

- Water for riparian water rights – includes Cowell Agreement[14] diversions on the Merced River.
- Spills – includes water that is present at the downstream ends of the distribution systems. These volumes are assumed to be the same for each LSJR alternative.
- Seepage from off-stream reservoirs – Woodward Reservoir, Turlock Lake, and Modesto Reservoir.

After subtracting the volumes listed above from the total diversions for each river, the remaining water was apportioned to the irrigation districts as applied surface water and conveyance losses (where conveyance losses are a fraction of applied surface water and spills). Applied water for agricultural purposes is a key component of the water balance; it comes from both surface water and groundwater, and includes water that is used consumptively by the crops (evapotranspiration) and water that percolates deep into the ground below the fields. The surface water portion of applied water was estimated as described above based on the WSE model results. The groundwater portion of applied water was estimated as described further below.

As a result of this post-processing method, when diversions were less than what was needed to meet full demands (of all categories of deliveries and losses), generally the only two categories of water that were assumed to be reduced were applied surface water and conveyance losses (which depend on the applied water). The model assumes reductions in applied water available to the irrigation districts. This assumption allows for a simplified approach to calculating groundwater impacts and produces a conservative estimate of agricultural impacts as described in Chapter 11, *Agricultural Resources* (i.e., agricultural impacts may be overestimated rather than underestimated).

In the WSE model, SEWD and CSJWCD diversions from the Stanislaus River were calculated separately from the SSJID and OID diversions. This is because SEWD and CSJWCD are CVP contractors and only receive water after SSJID and OID water rights have been met. As a result, in some years SEWD would not be able to provide Stanislaus River water to its municipal users, but these municipal needs would be met by either Calaveras River water or groundwater. The division of water between CSJWCD and SEWD was based on their contracts for Stanislaus River water. The division of Stanislaus River water between SSJID and OID and Tuolumne River water between MID and TID was calculated as part of post-processing. The division assumes that each district would receive the same percentage of surface water demand for consumptive use, as described in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Assessment of Irrigation District Groundwater Pumping

Within the irrigation districts, there is a minimum amount of groundwater pumping that occurs every year. If the amount of minimum groundwater pumping plus the amount of applied surface water is insufficient to meet the irrigation district's total demand for applied water (consumptive use and deep percolation), then additional groundwater pumping would occur up until a maximum amount. Minimum and maximum groundwater pumping estimates were based on an evaluation of irrigation district pumping estimates in CALSIM, 2012 AWMPs, 2010 GWMPs, and information provided by the irrigation districts. The final values primarily came from the AWMPs and the irrigation districts; they are listed in Appendix G. While maximum groundwater pumping can reduce agricultural impacts, it increases the potential for groundwater impacts.

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[14] The Cowell Agreement is a 1930's adjudicated agreement between MID and landowners flanking portions of the Merced River riparian areas. Per the Cowell Agreement, MID provides up to 50 cfs in February and up to 100 cfs in March downstream of the Crocker Huffman Diversion Dam.

Because baseline is representative of 2009 infrastructure, the primary groundwater analysis utilizes estimates of maximum groundwater pumping that were possible in 2009. However, recent drought conditions have resulted in more wells being drilled. Therefore, estimates of maximum groundwater pumping for 2014 were also assessed, as discussed below in Section 9.4.3, *Impacts and Mitigation Measures*. All 2014 maximum groundwater pumping estimates are greater than the 2009 maximum groundwater estimates, with the exception of Merced ID, where 2009 and 2014 estimates are the same. This is reasonable because Merced ID's 2009 capacity for increased groundwater pumping was almost sufficient to meet full demand in drought years.

As mentioned above and described in Appendix G, the primary data sources used for estimating the parameters needed for the groundwater assessment were the AWMPs, GWMPs, CALSIM, and information provided by the irrigation districts. Because there are many sources of information available regarding groundwater and because there is a large degree of uncertainty in the values, the values chosen for this analysis and the results of this analysis are not always the same as the water balance terms discussed in Section 9.2, *Environmental Setting*.

Evaluation of Irrigation District Groundwater Balance and Impacts

For the analysis of potential groundwater impacts associated with the LSJR alternatives, the net annual change in the irrigation district groundwater balance was estimated for each groundwater subbasin. The annual net contribution of irrigation district water to the groundwater subbasins was calculated by summing the off-stream reservoir seepage, conveyance losses, and deep percolation and subtracting total groundwater pumping for each irrigation district overlying the subbasin. As discussed in Section 9.2.2, *Subbasin Groundwater Use*, two irrigation districts (OID and Merced ID) affect the results for two subbasins because their service area boundaries are not confined to a single subbasin. The OID service area overlies the Eastern San Joaquin and Modesto Subbasins and the Merced ID service area overlay the Turlock and Extended Merced Subbasins. Hereafter, this chapter refers to the subbasin groundwater balance as the "irrigation district groundwater balance." For SEWD and CSJWCD, only the portion of their water use that could be affected by water supply from the Stanislaus River was included in the analysis.

The effect of the LSJR alternatives on the irrigation district groundwater balance is evaluated by comparing the irrigation district groundwater balance under each of the LSJR alternatives with the irrigation district groundwater balance under baseline conditions. The difference in the irrigation district groundwater balance was then divided by the total surface area of the groundwater subbasin; the result would have units of volume per area, expressed in inches (Table 9-12), which represents the height of the volume of water if it were spread evenly over the subbasin. Normalizing the change in groundwater balance by the subbasin area translates the effect into height and directly shows how average groundwater level could be impacted under the LSJR alternatives. An average decrease in irrigation district groundwater balance equivalent to 1 inch per year or more was considered to be a significant impact.

The estimated average specific yield for the Eastern San Joaquin, Modesto, Turlock, and Extended Merced Subbasins ranges from 7 to 10 percent, based on aquifer information presented in DWR Bulletin 118 (DWR 2003b, 2003c, 2003d, 2003e). The specific yield is the ratio of the volume of water a sample of saturated soil will yield by gravity drainage to the total volume of the soil (i.e., the portion of groundwater that could be available for extraction from the saturated soil). For example, a specific yield of 10 percent means that a reduction in groundwater volume equivalent to 1 inch across the subbasin is comparable to an average decrease in groundwater level of approximately

10 inches in an unconfined aquifer. This 10-inch decline in the groundwater level is similar to the estimated historical groundwater level declines shown the first two columns of Table 9-4. This 10-inch decline in groundwater levels would occur in addition to any decline in groundwater levels that occurred under baseline conditions. As such, a 1-inch decrease in the irrigation district groundwater balance across a subbasin caused by the LSJR alternatives could eventually produce a measurable decline in groundwater levels and a substantial depletion of groundwater resources. Therefore, a threshold of a 1-inch reduction in the irrigation district groundwater balance is used in the impact analysis in Section 9.4.3, *Impacts and Mitigation Measures*.

If a groundwater basin has a large volume of average inflow, outflow from the basin is also high because groundwater would drain to the rivers when groundwater elevations are high. Under these conditions, it is possible to pump groundwater without affecting groundwater elevations, although river flows would likely be affected. As discussed in Section 9.2, *Environmental Setting*, DWR's evaluation of groundwater in the San Joaquin Valley Groundwater Basin shows evidence of decreasing groundwater elevations, existing wide-scale groundwater pumping, and limited accretions to the rivers from groundwater. As such, it appears that the four subbasins are not in a state of excess supply. Therefore, a reduced groundwater supply, resulting from reduced recharge and increased pumping, would have a measurable effect on groundwater elevations in many locations.

Evaluation of Subsidence

Substantial groundwater depletion in an area with soils that are susceptible to inelastic compaction could result in subsidence. For this analysis, subsidence is considered to be significant if substantial groundwater depletion is expected to occur (i.e., if the GW-1 impact is significant and unavoidable) in an area where subsidence has previously occurred. Within the study area the main area of subsidence is in the southern portion of the Extended Merced Subbasin, especially in the area near El Nido. Despite reports of periods of declining groundwater levels, subsidence has not been reported for the other three subbasins of interest.

Adaptive Implementation

This chapter evaluates the potential groundwater impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February-June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, that would otherwise result from implementation of the February-June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.
4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February-June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (for example monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water.

The quantitative results included in the figures, tables, and text of this chapter present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). However, the modeling does allow some inflows to be retained in the reservoirs after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects and this is included in the results presented in this chapter. If the percent of unimpaired flow is not specified in this chapter, these are the percentages of unimpaired flow evaluated in the impact analysis. However, as part of adaptive implementation method 1, the required percent of unimpaired flow could change by up to 10 percent if the STM Working Group agrees to adjust it. The highest possible percent of unimpaired flow associated with an LSJR alternative is also evaluated in the impact analysis if long-term implementation of method 1 has the potential to affect a determination of significance. For example, if the determination for LSJR Alternative 2 at 20 percent unimpaired flow is less than significant, but the determination for LSJR Alternative 3 at 40 percent unimpaired flow is significant, then LSJR Alternative 2 is also evaluated at the 30 percent unimpaired flow. This use of modeling provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

Baseline

Results of the baseline groundwater analysis are presented here to illustrate the modeling methods and to show what was used as the basis of comparison for the LSJR alternatives. See Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, for a more extensive discussion of the model results.

In the first step of the analysis the WSE model diversions were partitioned between different types of deliveries and losses. For example, Figure 9-6 shows this partitioning for baseline conditions for the Stanislaus River. On the Stanislaus River, the largest portion of baseline diversions usually goes to the consumptive use of applied water by agriculture (CUAW). This is also true for the Tuolumne and Merced Rivers (Appendix G). However, during drought conditions the amount of water available for agriculture is greatly reduced. This is particularly apparent in the results for 1934, 1977, and 1992 (Figure 9-6).

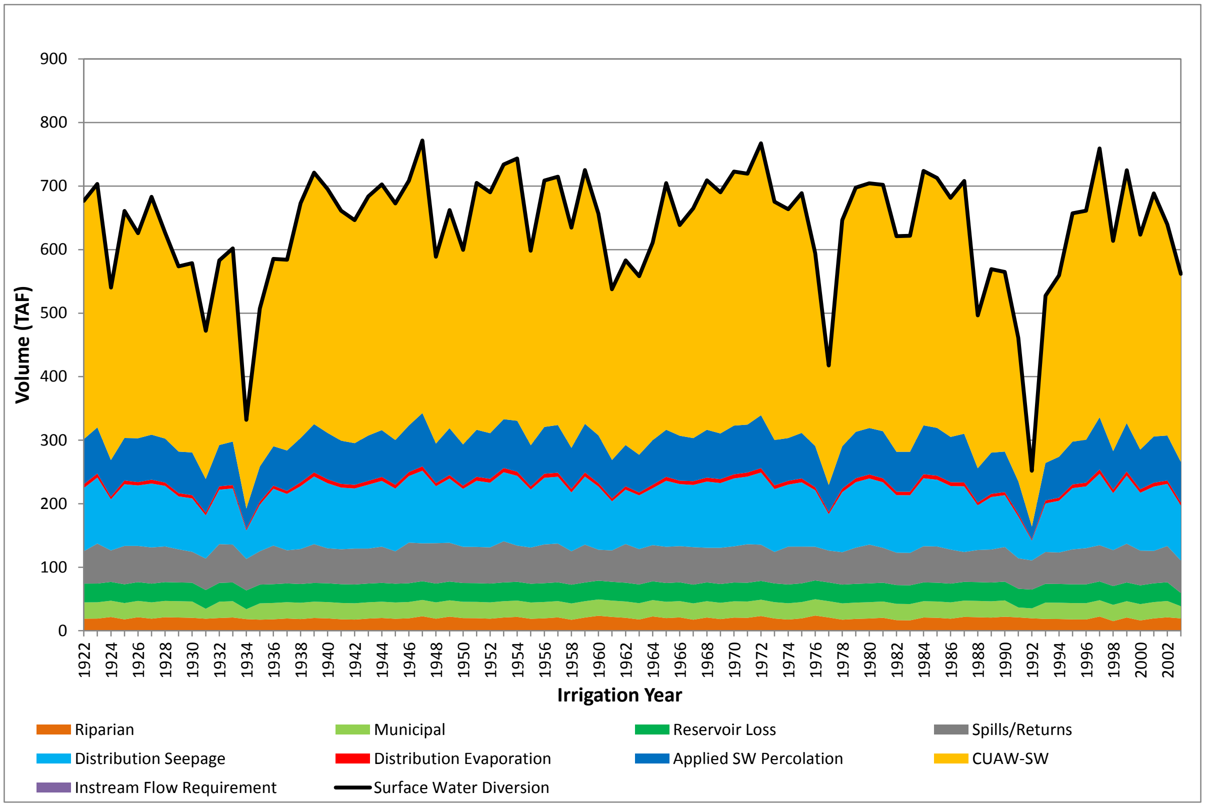


Figure 9-6. Partitioning of Baseline Diversions from the Stanislaus River into End Uses

In years with low water supply, surface water diversions are not sufficient to meet full agricultural demand for applied water (for CUAW and deep percolation). As a result, groundwater pumping increases. Even under baseline conditions, there are years when increases in groundwater pumping are expected to be unable to meet the full agricultural demand of the irrigation districts that obtain surface water from the Stanislaus, Tuolumne, and Merced Rivers (Figures 9-7a, 9-7b, and 9-7c, respectively).

The capacity of each irrigation district to pump groundwater varies and depends on existing infrastructure (Table 9-6 and Appendix G). The capacity for increased groundwater pumping by Merced ID is almost sufficient to meet full demand in drought years. There is moderate capacity to compensate for a reduction in surface water supply on the Stanislaus River, but this comes largely from SEWD and CSJWCD, which can fully compensate for a reduction in their Stanislaus River supply. In contrast, SSJID and OID have only a limited ability to increase groundwater pumping because their surface water supply has historically been reliable, and they have not needed to increase their groundwater pumping capacity. The Tuolumne River irrigation districts, TID and MID, have similarly limited ability to increase groundwater pumping (Table 9-6 and Appendix G).

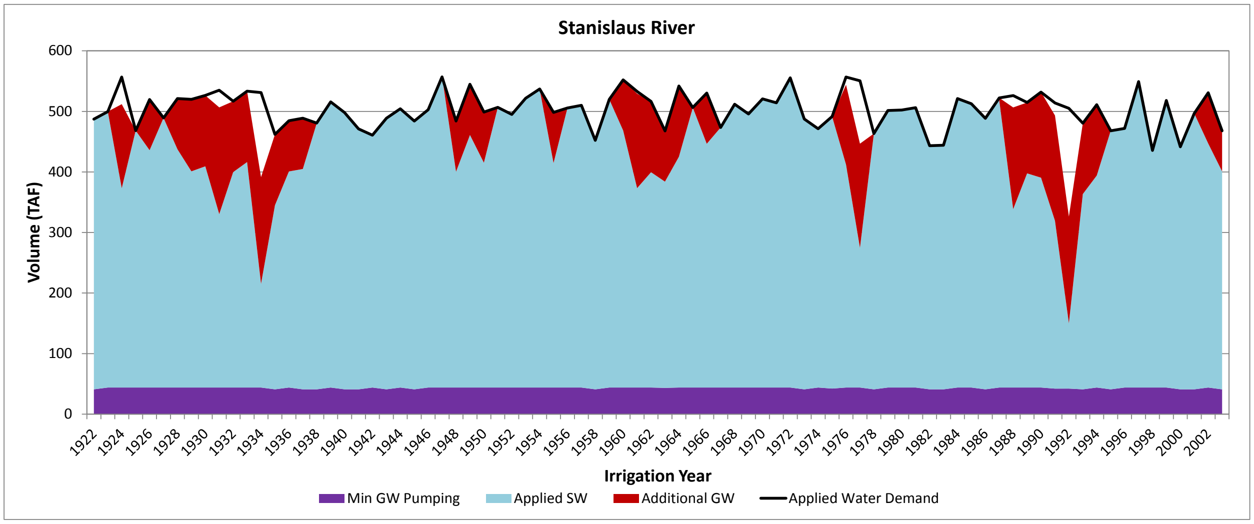


Figure 9-7a. Baseline Groundwater and Surface Water Application to Meet Applied Water Demand for the Stanislaus River

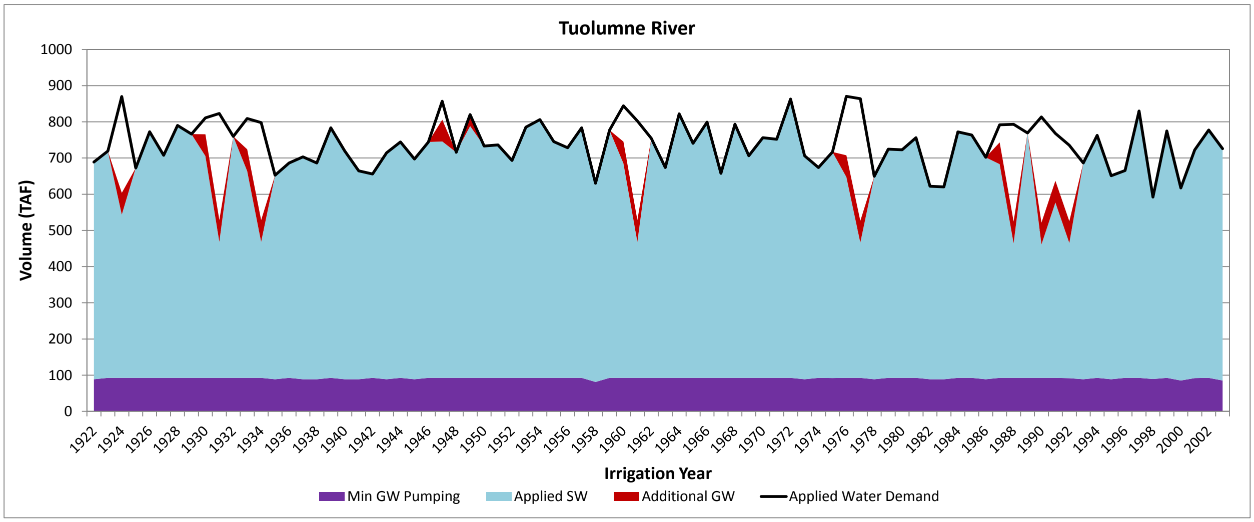


Figure 9-7b. Baseline Groundwater and Surface Water Application to Meet Applied Water Demand for the Tuolumne River

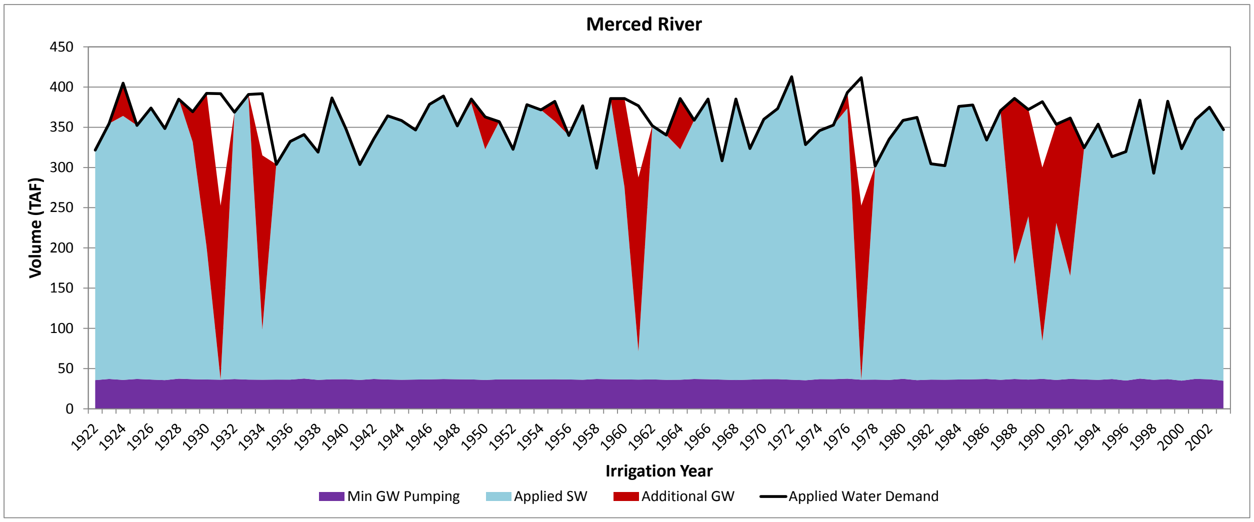


Figure 9-7c. Baseline Groundwater and Surface Water Application to Meet Applied Water Demand for the Merced River

Under baseline conditions, during most years, irrigation districts contribute more surface water to groundwater stores (i.e., recharge) than the irrigation districts remove by groundwater pumping. However, under drought conditions, seepage from the conveyance system and deep percolation from applied surface water is reduced while groundwater pumping increases. For example, in the Stanislaus River drought conditions can cause the irrigation districts to temporarily become net users of groundwater (Figure 9-8). However, in general the irrigation district contributions to groundwater help to offset the groundwater pumping for irrigated land outside of the irrigation districts, which is primarily irrigated with groundwater (Table 9-6).

The baseline contribution of the irrigation districts to the subbasins is typically 100–200 TAF/y if surface water supply meets the irrigation district needs (Figure 9-9). However, during drought, contributions to groundwater are reduced, and in some years, the irrigation districts overlying the Eastern San Joaquin and Extended Merced Subbasins become net users of groundwater under baseline conditions. Drought affects the net irrigation district contribution to groundwater more often in the Eastern San Joaquin Subbasin than for the other subbasins. However, during the worst droughts, drought affects the Extended Merced Subbasin more severely. The severity and frequency of water shortages and the ability of the irrigation districts to increase groundwater pumping directly affects the irrigation district contributions to the subbasins.

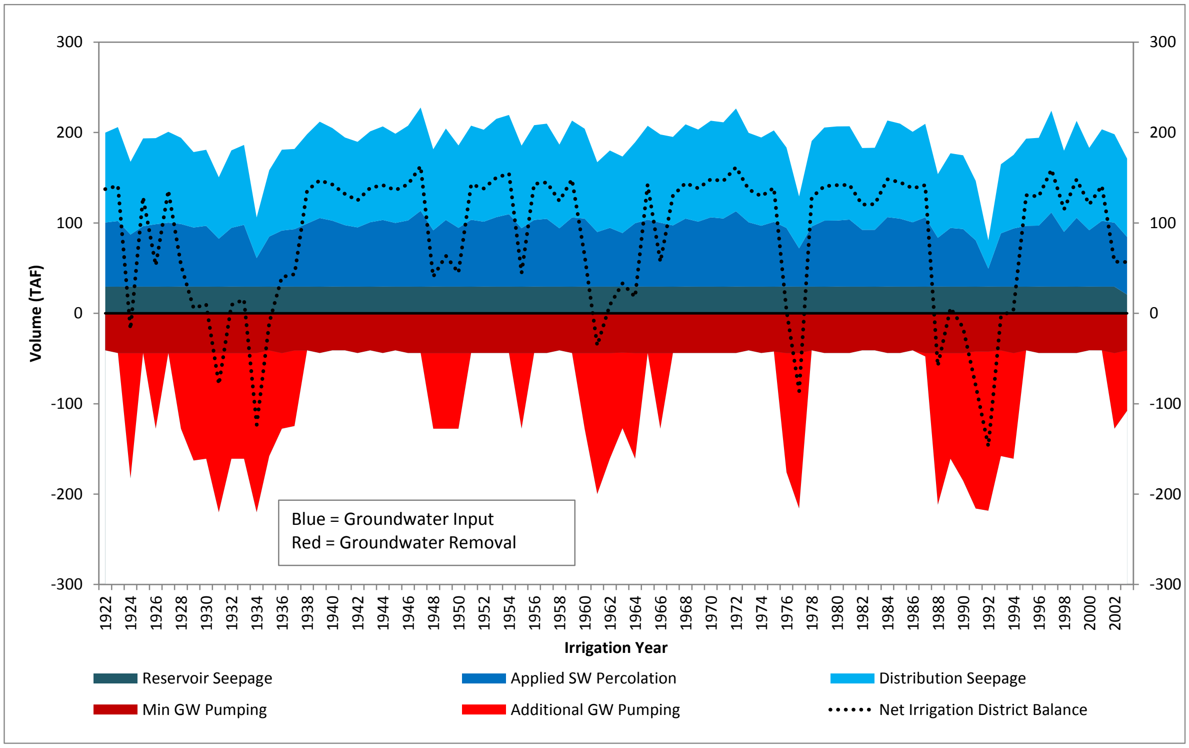


Figure 9-8. Effect of Stanislaus River Irrigation Districts on Baseline Groundwater Balance

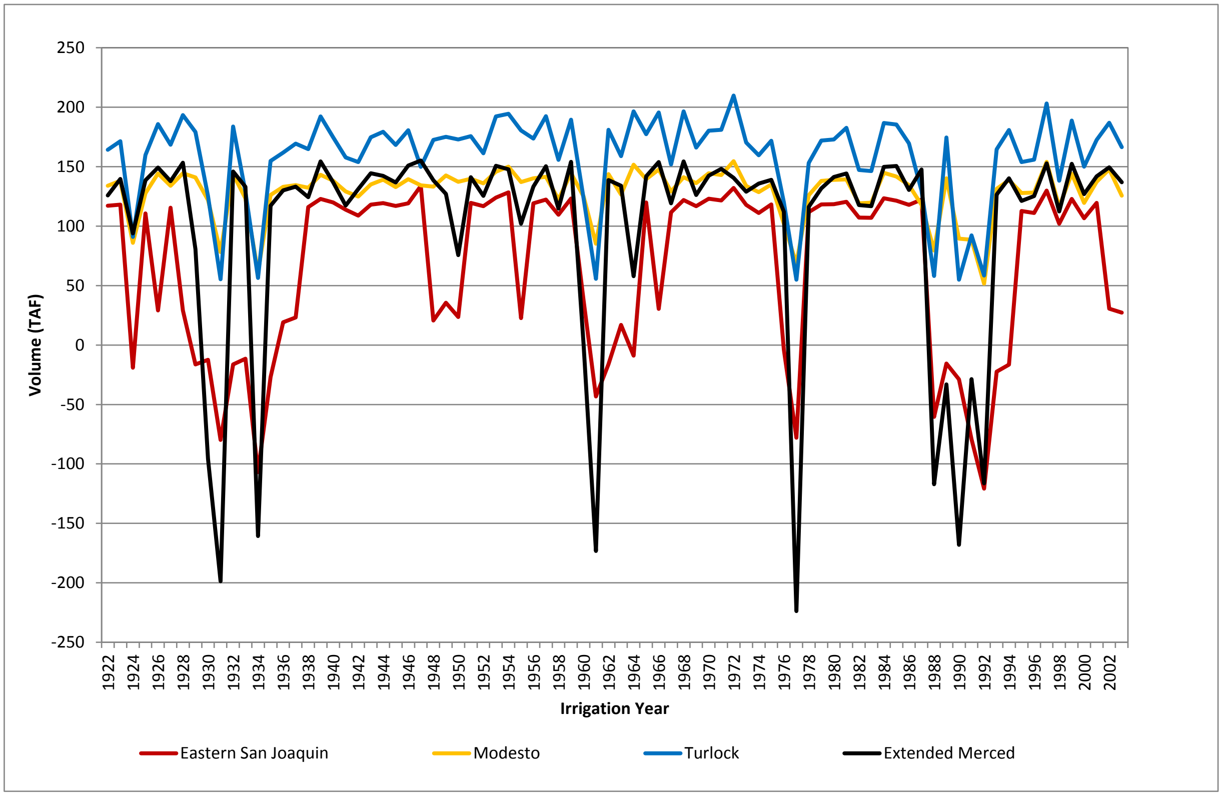


Figure 9-9. Net Annual Contribution to Groundwater Subbasins by the Irrigation Districts under Baseline Conditions

Extended Plan Area

In this chapter, the analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

The SDWQ alternatives are not considered in this analysis, as described in Section 9.2.4, *Southern Delta*, and Appendix B, *State Water Board's Environmental Checklist*, because increased groundwater pumping or reduced groundwater recharge would not occur as a result of a change to the salinity objective.

9.4.3 Impacts and Mitigation Measures

Impact GW-1: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge

No Project Alternative (LSJR/SDWQ Alternative 1)

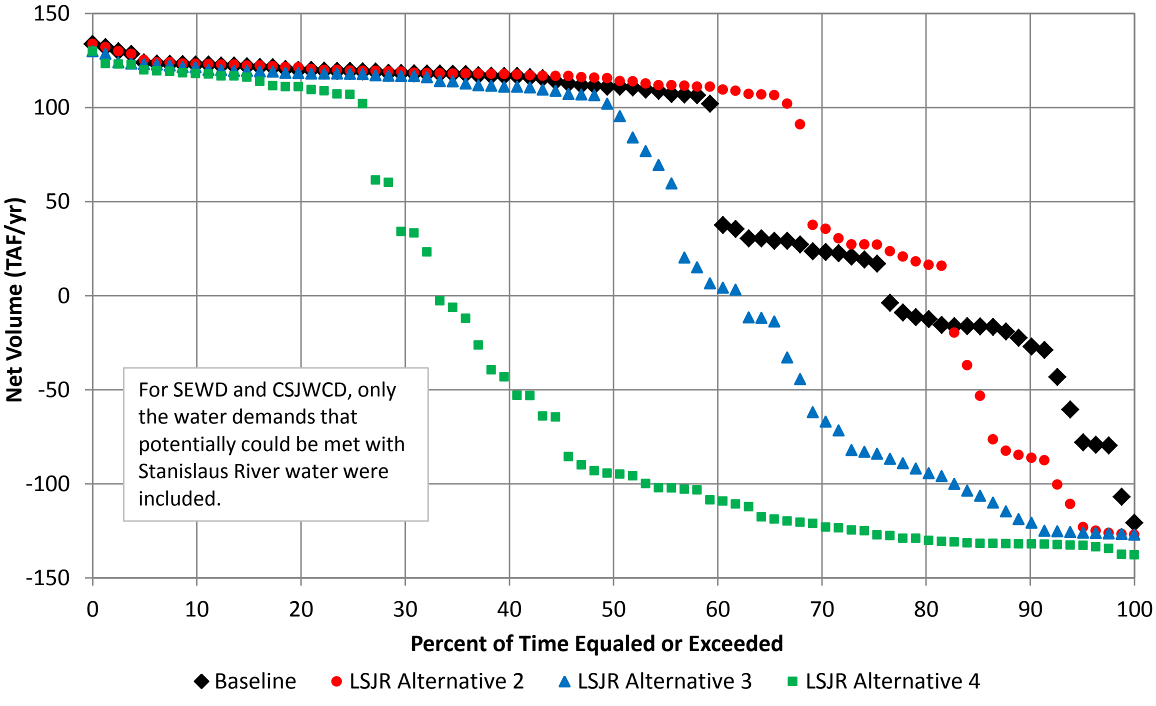
The No Project Alternative would result in implementation of flow objectives identified in the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan). See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the technical analysis of the No Project Alternative.

LSJR Alternatives

Baseline groundwater pumping is extensive in the four subbasins. Groundwater pumping is conducted by the irrigation districts and water districts, other water purveyors (e.g., cities and counties), and individual landowners. In dry years, irrigation districts use groundwater to compensate for reduced surface water supplies. However, on average, the irrigation districts (SSJID, OID, MID, TID, Merced ID, and the portions of SEWD and CSJWCD that use Stanislaus River water) provide net recharge to the groundwater aquifer and help compensate for groundwater pumping outside of the irrigation district lands, which is greater than groundwater pumping within the irrigation districts (Table 9-6).

A reduction in surface water supply may affect the groundwater aquifer by simultaneously causing a reduction in recharge volume (by reducing deep percolation from the distribution system and agricultural fields) and an increase in groundwater pumping (to replace lost surface water supplies). If the irrigation districts were able to use groundwater to fully replace any decreases in surface water needed for irrigation of crops, then the effect of the LSJR alternatives on groundwater would be approximately equal to the decrease in river diversions (with a minor difference due to evaporation from the distribution system). If the irrigation districts were not able to use groundwater to compensate for a reduction in surface water supply, then the effect of the LSJR alternatives on groundwater would be equal to the reduction in percolation from the distribution system plus the reduction in percolation from applied water. Because the irrigation districts have some ability to replace reductions in surface water supply with groundwater, the effect of the LSJR alternatives on the change in the groundwater balance is a volume that is between the reduction in diversion volume (maximum groundwater effect) and the reduction in percolation volume from the distribution system and applied water (minimum groundwater effect).

A comparison of the irrigation districts' estimated baseline net groundwater balances to the estimated values for the LSJR alternatives indicates that, as the specified percent of unimpaired flow increases, pumping increases, and groundwater recharge is reduced. Figures 9-10 through 9-13 illustrate this effect and show the percent of the time that net irrigation district contributions to each groundwater basin were equaled or exceeded for each LSJR alternative. Lower values (i.e., less recharge) typically occurs under dry conditions, with more reductions in recharge occurring when higher percentages of unimpaired flow are required. The irrigation districts almost always have a positive effect on the groundwater balance in the Modesto and Turlock Subbasins (Figures 9-11 and 9-12, respectively); however, the Turlock Subbasin balance is occasionally negative under LSJR Alternative 4 (Figure 9-12). The net effect of the irrigation districts on the groundwater balance may be negative, even under baseline conditions, in the Eastern San Joaquin and Extended Merced Subbasins (Figures 9-10 and 9-13, respectively).



For SEWD and CSJWCD, only the water demands that potentially could be met with Stanislaus River water were included.

Figure 9-10. Annual Net Contribution to the Eastern San Joaquin Subbasin by SSJID, OID, SEWD, and CSJWCD

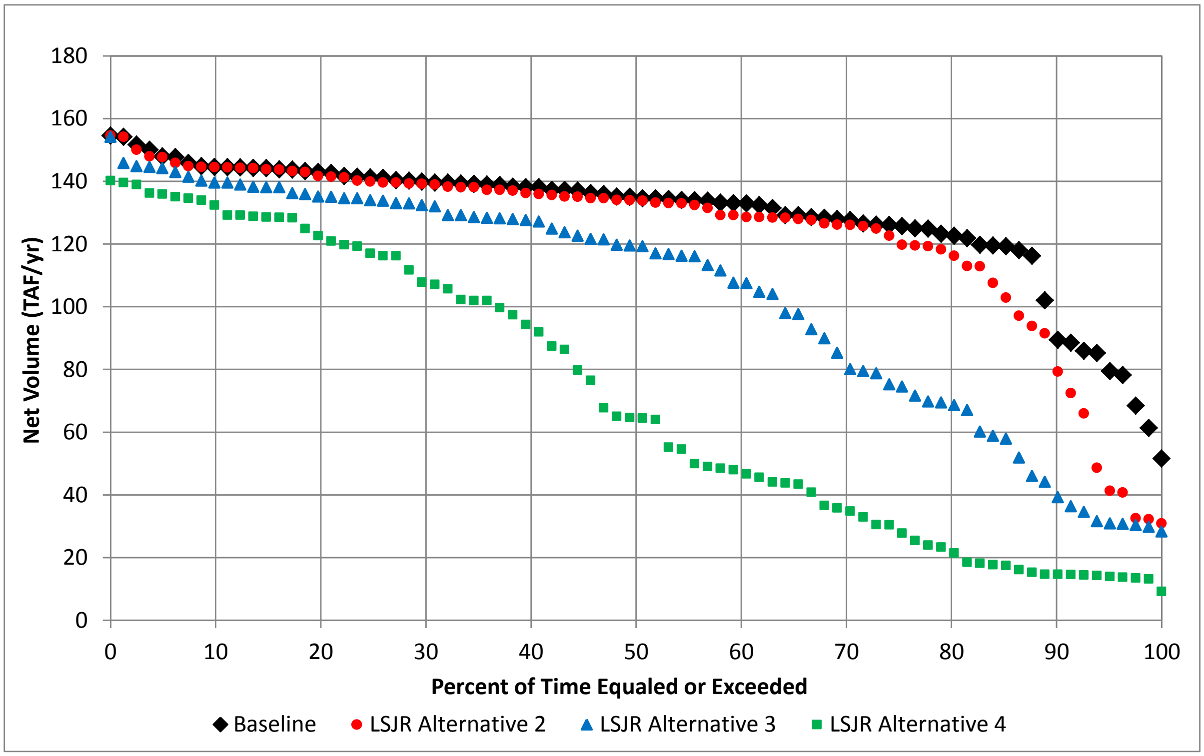


Figure 9-11. Annual Net Contribution to the Modesto Subbasin by MID and OID

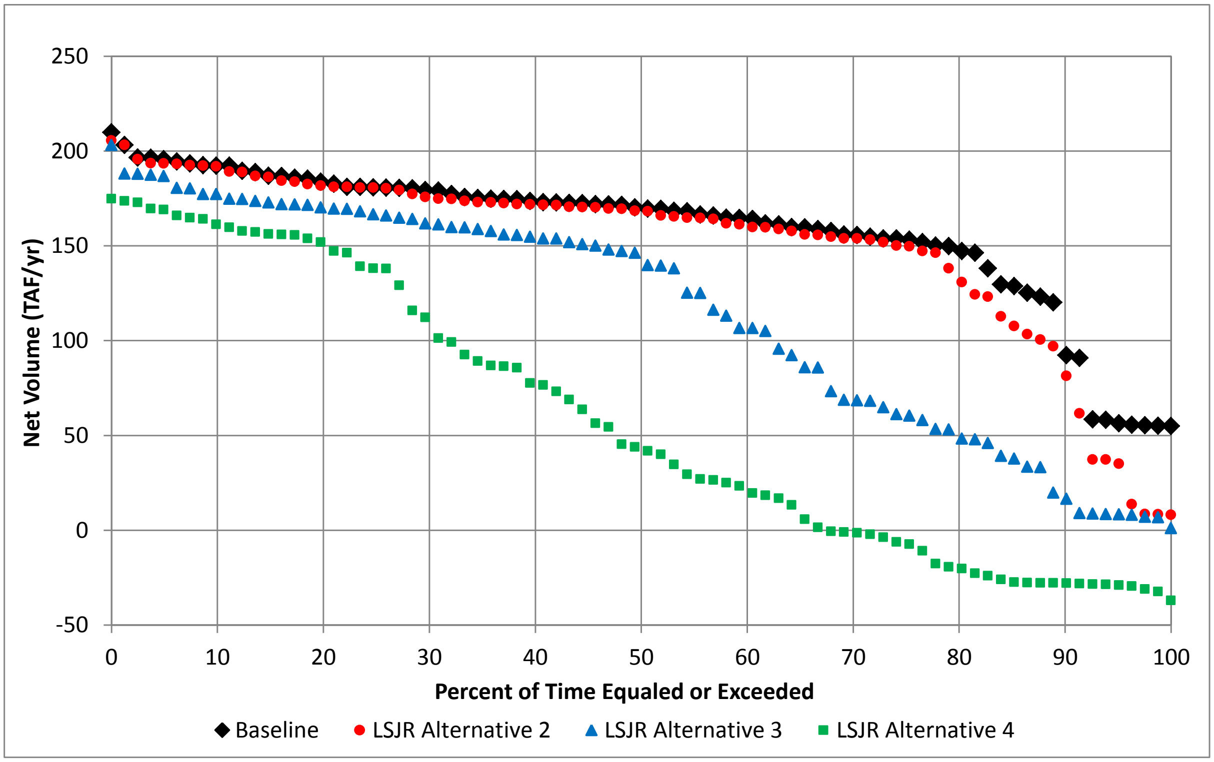


Figure 9-12. Annual Net Contribution to the Turlock Subbasin by TID and MID

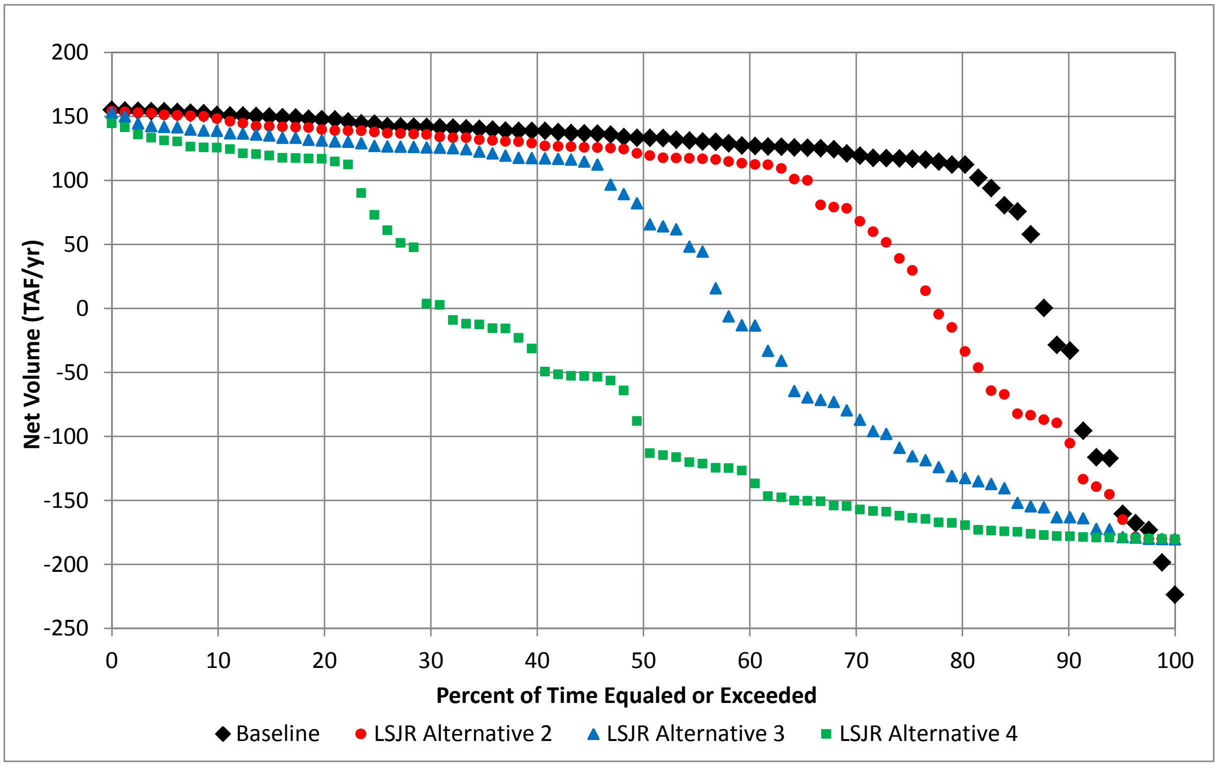


Figure 9-13. Annual Net Contribution to the Extended Merced Subbasin by MID

As described in Section 9.4.2, *Methods and Approach*, this analysis was performed using estimates of maximum groundwater pumping capacity based on 2009 infrastructure. Table 9-12 provides a summary of the average annual net change in the groundwater balance caused by each LSJR alternative, expressed in terms of inches of water spread over the entire subbasin. Table 9-12 also includes results assuming maximum groundwater pumping capacity based on 2014 infrastructure. These results are addressed in more detail in the following sections, which discuss the potential impacts associated with each alternative.

Table 9-12. Average Annual Net Change in Irrigation District Groundwater Balance Associated with the LSJR Alternatives per Subbasin Area

				Decrease in Groundwater Balance Per Subbasin Area (inches)			
				LSJR Alternative 2		LSJR Alternative 3	LSJR Alternative 4
Groundwater Subbasin	Total Area (1,000 acres)	Baseline Irrigation District Groundwater Balance (TAF) (positive indicates recharge)	Baseline Irrigation District Recharge Per Subbasin Area (inches)	20 Percent Unimpaired Flow	Adaptive Implementation Method 1: 30 Percent Unimpaired Flow		
Results assuming maximum groundwater pumping based on 2009 infrastructure							
Eastern San Joaquin	707	65	1.1	0.0	0.1	0.6	1.7
Modesto	247	129	6.3	0.3	0.6	1.2	2.8
Turlock	349	158	5.4	0.3	0.7	1.5	3.4
Extended Merced	517	99	2.3	0.7	1.2	1.9	3.5
Results assuming maximum groundwater pumping based on 2014 infrastructure							
Eastern San Joaquin	707	64	1.1	0.0	0.2	0.7	1.9
Modesto	247	120	5.8	0.4	1.1	2.2	5.0
Turlock	349	146	5.0	0.3	1.1	2.2	5.0
Extended Merced	517	99	2.3	0.7	1.2	1.9	3.5

LSJR Alternative 2(Less than significant/Significant and unavoidable with adaptive implementation)

Estimated average net irrigation district groundwater balance under LSJR Alternative 2 is predicted to be either similar to or slightly less than under baseline conditions, with the decrease being most noticeable in the Extended Merced Subbasin (Figures 9-10 through 9-13). The predicted small changes are driven by the small changes to average surface water diversions under LSJR Alternative 2. Under baseline and LSJR Alternative 2, the irrigation districts contribute to groundwater recharge in most years, with the exception that the irrigation district groundwater balance becomes negative in the Eastern San Joaquin and Extended Merced Subbasins during approximately the driest 20 percent and 10 percent of years, respectively (Figures 9-10 through 9-13). The average reduction in annual net groundwater recharge under LSJR Alternative 2 relative to baseline is equivalent to 0.0-0.7 inches of water across each of the four subbasins (with 0.0 inches being for the Eastern San Joaquin Subbasin and 0.7 inches being for the Extended Merced Subbasin [Table 9-12]). These changes are less than the 1 inch threshold for significance.

When the maximum groundwater pumping capacity for 2014 is used in the analysis instead of the estimates for 2009, the results show small increases in baseline pumping in the Eastern San Joaquin, Modesto, and Turlock Subbasins under baseline conditions. However, the only noticeable change in the effect of LSJR Alternative 2 on groundwater recharge would be slightly less recharge for the Modesto Subbasin (reduction in recharge would increase from 0.3 to 0.4 inches across the subbasin [Table 9-12]). The largest effect of switching from the 2009 to 2014 maximum groundwater pumping capacity is in the Modesto Subbasin because MID had a relatively large increase in groundwater pumping capacity between 2009 and 2014 (Table G.2-4) and the smallest acreage (Table 9-12).

As described in Section 9.2.1, *San Joaquin Valley Groundwater Basin and Subbasins*, a change in groundwater flow can indirectly influence groundwater quality. Under LSJR Alternative 2, the direction of groundwater flow would not change such that any existing localized groundwater contamination in the subbasins would be affected. Therefore, there would likely be no degradation of groundwater quality under LSJR Alternative 2. Furthermore, LSJR Alternative 2 would not cause a significant amount of applied surface water, which has relatively low EC, to be replaced with applied groundwater, which has relatively high EC (surface water from the Stanislaus, Tuolumne, and Merced Rivers generally has much lower salinity than groundwater). Consequently, LSJR Alternative 2 would not cause an increase in salinity concentrations in the groundwater subbasins.

Therefore, at the 20 percent unimpaired flow level, the slight reduction in recharge under LSJR Alternative 2, as compared to baseline, would not likely result in groundwater quality impacts or a significant reduction in groundwater levels.

Adaptive Implementation

As discussed above, based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20 percent February-June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects, as compared to 20 percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. If this adjustment occurs frequently or for extended durations, impacts under LSJR Alternative 2 could become more like the impacts under LSJR Alternative 3. At the 30 percent unimpaired flow level, impacts on groundwater would increase relative to the 20 percent unimpaired flow level (Table 9-12) and could reach the equivalent of 1.2 inches across the Extended Merced Subbasin (i.e., greater than the threshold of significance). If the 2014 maximum groundwater pumping capacity values are used for the assessment, estimated groundwater impacts become significant for the Modesto and Turlock Subbasins and the Extended Merced Subbasin (Table 9-12).

As described in Section 9.2.1, *San Joaquin Valley Groundwater Basin and Subbasins*, a change in groundwater pumping can indirectly influence groundwater quality. Under LSJR Alternative 2 with adaptive implementation, a reduction in groundwater levels in the Extended Merced Subbasin could cause a degradation of groundwater quality as a result of changes in the direction of groundwater flow. However, specifically determining the changes to groundwater quality is speculative as it is dependent of many factors including, but not limited to, the location of groundwater pumping, the amount of groundwater pumped, the frequency at which pumping would occur, location of contaminants, the type of contaminants (e.g., water soluble or not), proximity of contamination to aquifers, hydrogeological characteristics of the aquifer, individual well construction, well depth, groundwater levels, and localized conditions, such as proximity to unused or abandoned wells. However, while specifically determining the changes to groundwater quality is speculative, it is reasonable to assume that localized groundwater contamination that exists in the subbasins could move in undesirable directions (i.e., toward water supply wells) and reduction in deep percolation of the relatively low EC surface water could also affect groundwater quality by causing a gradual increase in salinity. Consequently, LSJR Alternative 2, with the incorporation of adaptive implementation method 1, could potentially substantially deplete groundwater supplies and interfere with groundwater recharge and affect groundwater quality in these subbasins. Therefore, impacts on groundwater resources would be potentially significant and unavoidable.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February-June time frame. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7 day running average) unimpaired flow rate. Adaptive implementation method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. A change in the timing of the flow releases would not have an effect on groundwater recharge or groundwater quality. Adaptive implementation method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. WSE model results indicate changes due to adaptive implementation method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR, and thus would not affect groundwater. Accordingly, LSJR Alternative 2, with the incorporation of adaptive implementation methods 2 and 4, would not substantially deplete groundwater supplies and affect groundwater quality.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Mitigation to reduce significant impacts on groundwater resources could include the State Water Board or local agencies exercising their various authorities over groundwater users, including authorities under SGMA.

SGMA is now the state's primary sustainable groundwater management law. Under the SGMA framework, local agencies are tasked with protecting and managing high and medium priority groundwater basins with state intervention to begin by specified dates if local agencies are unwilling or unable to manage. The SGMA deadlines for state intervention are still prospective; therefore, State Water Board mitigation to protect the groundwater basin from the indirect impacts of the LSJR alternatives is infeasible at this time, but mitigation under local authorities is both feasible and required.

Possible mitigation measures to reduce or avoid any potential effects include those listed below.

- Identify the basin's sustainable yield and implement enforceable groundwater management measures (for maximum pumping or minimum water levels) so that reductions in groundwater pumping would result if certain thresholds are met.
- Establish water conservation measures, such as increased efficiency for municipal and industrial uses or conversion of irrigated land to crops that require less water, such that reductions in groundwater pumping would result.
- Establish a conjunctive water management program that would divert surface water during non-irrigation months (e.g., October–April) during wet years into unlined canals and designated fields to recharge the groundwater basin.

Local governments have police powers and groundwater management authority, but that authority was not exercised in most of the state to protect groundwater resources, including in areas that have long been recognized as being critically overdrafted. Although local governments could and should have regulated groundwater pumping to avoid, arrest, or reverse conditions of long-term overdraft, this regulatory authority was not typically used under baseline conditions. However, SGMA now requires that local agencies form GSAs by June 30, 2017. In the critically overdrafted Eastern San Joaquin, Merced, and Chowchilla Subbasins, those GSAs must develop and implement GSPs by January 31, 2020, while GSAs in the Modesto and Turlock Subbasins must adopt GSPs by January 31, 2022. Each GSP must also include measureable objectives as well as milestones in increments of 5 years, to achieve the sustainability goal in the basin within 20 years of the implementation of the GSP. (Wat. Code, § 10727.2.)

Thus, at this time, local agencies are vested with the mandatory duty to achieve sustainable groundwater management, which includes not causing undesirable results such as significant and unreasonable reduction of groundwater storage and degradation of water quality. Therefore, these local agencies with authority over the Extended Merced Subbasin can and should exercise their full authorities to address substantial depletion of groundwater supplies and water quality degradation, both under SGMA and their police powers. Under that authority, they can and should also implement those mitigation measures identified above. Doing so would prevent groundwater depletion and water quality impacts, mitigate those impacts, or both.

The State Water Board has several authorities that are independent of SGMA, including authority to take action to prevent waste, unreasonable use, unreasonable method of use, and unreasonable method of diversion of water. The State Water Board may exercise this authority through quasi-adjudicative or quasi-legislative proceedings. However, it is infeasible for the State Water Board to impose mitigation measures to prevent waste and unreasonable use at this time because it is undertaking a programmatic analysis of the potential groundwater resource impacts and does not have specific facts associated with an individual project to legally and technically apply requirements to prevent waste and unreasonable use in an adjudicative proceeding. In addition, while the State Water Board may impose water conservation or efficiency requirements through the adoption of regulations, the amount of time, high cost, and commitment of staff resources associated with such rule-making proceedings also renders adopting the mitigation measures now infeasible. Adopting regulations right now would require considerable staff time to research, formulate and develop, require extensive stakeholder outreach, and require numerous public meetings before the regulations would take effect. The State Water Board currently has limited resources to pursue adoption of such regulations as most of its budget for the water right program is supported by fees imposed on water right permit and license holders, and is used for program activities related to the diversion and use of water subject to the permit and license system. Only a small amount of funding is available for other regulatory activities and it is speculative to anticipate that additional funding will be made available.

The State Water Board's water quality control planning process relies on periodic reviews of the Bay-Delta Plan. As a result, the planning process continually accounts for changing conditions related to water quality and water planning. As additional information and data are gathered regarding groundwater pumping in the subbasins, SGMA milestones, and SGMA compliance, the State Water Board can and will revisit and analyze the groundwater condition during the periodic review of the water quality control plan. Where and when appropriate, it will also exercise its independent but complementary authorities under SGMA to ensure sustainable management of the groundwater basins in the plan area. Due to the infeasibility of mitigation by the State Water Board at this time and the inherent uncertainty in the degree to which this mitigation may be implemented by local agencies, particularly in the near-term, impacts on groundwater resources under LSJR Alternative 2 with adaptive implementation would remain significant and unavoidable.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Estimated net irrigation district groundwater balance under LSJR Alternative 3 is predicted to be lower than under baseline conditions. The effect of LSJR Alternative 3 on groundwater could be largest in years with less than median water availability, but even wet years could experience some small effects in the Modesto, Turlock, and Extended Merced Subbasins (Figures 9-10 through 9-13). Under LSJR Alternative 3, the irrigation districts would still contribute to groundwater recharge in most years, although the irrigation district groundwater balance could become negative in the Eastern San Joaquin and Extended Merced Subbasins during approximately the driest 40 percent of years (i.e., more often than under baseline and LSJR Alternative 2) (Figures 9-10 through 9-13). Even when the net irrigation district groundwater balance is positive, a decrease in the recharge could be detrimental because it could reduce the amount of compensation for groundwater pumping that happens outside of the irrigation district lands.

Under LSJR Alternative 3 there would be more water in the rivers that could recharge the groundwater basins. However, it is unlikely that recharge from the rivers would increase significantly because the amount of recharge from the rivers is not large under existing conditions (USGS 2015) and the average wetted width of the channel would not increase greatly as a result of LSJR Alternative 3. If groundwater level decreases over time, the aquifer may eventually no longer intersect with portions of the rivers. This could also cause an increase in groundwater recharge from the rivers, but is not likely to be substantial enough to compensate for changes in the irrigation district groundwater balances.

Physical changes to the subbasins would occur over time. In wet years, LSJR Alternative 3 could have little effect on groundwater levels, but in dry years, groundwater levels could potentially substantially decrease. The potential calculated reduction in recharge in terms of inches across the subbasins is just an indicator of substantial effect. As described in Section 9.4.2, *Methods and Approach*, 1 inch of water translates to an approximately 10-inch decrease in groundwater level. A decrease in groundwater levels would not be uniform across the subbasins. It would vary depending on the location and amount of recharge, groundwater extraction, and potential movement of groundwater from other locations.

The average reduction in net irrigation district groundwater balance under LSJR Alternative 3 could exceed 1 inch across the Modesto, Turlock, and Extended Merced Subbasins (Table 9-12). When the maximum groundwater pumping capacity for 2014 is used in the analysis instead of the estimates for 2009, the results show small increases in pumping in the Eastern San Joaquin, Modesto, and Turlock Subbasins under baseline conditions. The results also show somewhat greater increases in groundwater pumping under LSJR Alternative 3, which could potentially result in a larger decrease in groundwater elevations (Table 9-12). The largest modeled difference in results between the 2009 and 2014 maximum groundwater pumping capacities are in the Modesto Subbasin because MID had a relatively large increase in groundwater pumping capacity between 2009 and 2014 (Table G.2-4) and had the smallest acreage (Table 9-12). There is no change in the Extended Merced Subbasin because the subbasin saw no change in the estimated maximum groundwater pumping capacity between 2009 and 2014.

As described in Section 9.2.1, *San Joaquin Valley Groundwater Basin and Subbasins*, a change in groundwater pumping can indirectly influence groundwater quality. Under LSJR Alternative 3, reduction in groundwater levels in the Modesto, Turlock, and Extended Merced Subbasins could cause a degradation of groundwater quality as a result of changes in the direction of groundwater flow. Specifically determining the changes to groundwater quality is speculative as it is dependent upon many factors including, but not limited to, the location of groundwater pumping, the amount of groundwater pumped, the frequency at which pumping would occur, location of contaminants, the type of contaminants (e.g., water soluble or not), proximity of contamination to aquifers, hydrogeological characteristics of the aquifer, individual well construction, well depth, groundwater levels, and localized conditions, such as proximity to unused or abandoned wells. However, while specifically determining the changes to groundwater quality is speculative, it is reasonable to assume that localized groundwater contamination that exists in the subbasins could move in undesirable directions (i.e., toward water supply wells) and that reduction in deep percolation of the relatively low EC surface water could also affect groundwater quality by causing a gradual increase in salinity.

Because the average annual reduction in irrigation district groundwater balance under LSJR Alternative 3 would exceed 1 inch across the Modesto, Turlock, and the Extended Merced Subbasins, LSJR Alternative 3 could potentially substantially deplete groundwater supplies and interfere with groundwater recharge and affect groundwater quality in these subbasins. Therefore, impacts on groundwater resources would be potentially significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on groundwater resources. Adaptive implementation method 3 would result in a shift in the volume of February–June water available to other parts of the year and is included in the modeling results presented above for LSJR Alternative 3. Because this method would not affect diversions or the total annual volume of river flow, this method would not affect groundwater, and it would result in impacts similar to those already described. Adaptive implementation method 1 would allow an increase or decrease of up to 10 percent in the February-June 40 percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively. If the adjustment occurs frequently or for extended durations, based on the modeling results for LSJR Alternative 2, with adaptive implementation method 1 incorporated (i.e., 30 percent unimpaired flow), and LSJR Alternative 4, with adaptive implementation method 1 incorporated (i.e., 50 percent unimpaired flow), impacts would remain potentially significant and unavoidable.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Mitigation to reduce significant impacts on groundwater resources could include the State Water Board or local agencies exercising their various authorities over groundwater users, including authorities under SGMA.

As discussed in detail under LSJR Alternative 2 with adaptive implementation, the State Water Board has several authorities that are independent of SGMA but it is local agencies that are vested with the mandatory duty to achieve sustainable groundwater management, which includes not causing undesirable results such as significant and unreasonable reduction of groundwater storage and degradation of water quality. Therefore, these local agencies, with authority over Eastern San Joaquin Basin, Modesto, Turlock, and Extended Merced Subbasins can and should exercise their full authorities to address substantial depletion of groundwater supplies and water quality degradation, both under SGMA and their police powers. Under that authority, they can and should also implement those mitigation measures identified in LSJR Alternative 2 with adaptive implementation above. Doing so would prevent groundwater depletion and water quality impacts, mitigate those impacts, or both. Due to the inherent uncertainty in the degree to which this mitigation may be implemented by local agencies, however, impacts on groundwater resources under LSJR Alternative 3, with or without adaptive implementation, would remain potentially significant and unavoidable.

As further stated under LSJR Alternative 2 with adaptive implementation, the State Water Board can and will revisit and analyze the groundwater condition during the periodic review of the water quality control plan. Where and when appropriate, it will also exercise its independent but complementary authorities under SGMA to ensure sustainable management of the groundwater basins in the plan area.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

LSJR Alternative 4 could result in the greatest potential increase in groundwater pumping and reduction in recharge from the four subbasins, as compared to baseline levels (Table 9-12). LSJR Alternative 4 could result in physical environmental effects, such as decreases in water quality or a significant reduction in groundwater levels, similar to the impacts described under LSJR Alternative 3. However, LSJR Alternative 4 could result in less groundwater recharge from surface water and require more groundwater to be pumped than would be required under LSJR Alternative 3. As such, the impacts on groundwater levels and quality associated with LSJR Alternative 4 would potentially be greater than the impacts associated with LSJR Alternative 3.

Estimated annual net groundwater contributions from the irrigation districts under LSJR Alternative 4 are predicted to be much lower than under baseline conditions. The effect of LSJR Alternative 4 on groundwater pumping and recharge could be largest in years with less than median water availability, but even wet years could experience some small effects in the Modesto, Turlock, and Extended Merced Subbasins (Figures 9-11 through 9-13). Under LSJR Alternative 4, the irrigation districts would still contribute to groundwater recharge in many years, although the irrigation district groundwater balance could become negative in the Eastern San Joaquin, Turlock, and Extended Merced Subbasins during approximately 65 percent, 30 percent, and 70 percent of years, respectively (i.e., much more often than under baseline conditions) (Figures 9-10, 9-12, and 9-13). Even when the annual irrigation district groundwater balance is positive, a decrease in the recharge could be detrimental because it would reduce the amount of compensation for groundwater pumping that happens outside of the irrigation district lands.

As discussed under LSJR Alternative 3, increased flow in the rivers is expected to have only a small effect on the groundwater balance. The larger effects caused by a reduction in groundwater recharge, and an increase in groundwater pumping could vary year-to-year and location to location.

The average reduction in net irrigation district groundwater balance associated with LSJR Alternative 4 could exceed 1 inch across all four subbasins (Table 9-12). When the maximum groundwater pumping capacity for 2014 is used in the analysis instead of the estimates for 2009, average net contribution from the irrigations districts decreases further, as compared to baseline, by the equivalent of an additional 0.2, 2.2, 1.6, and 0.0 inches for the Eastern San Joaquin, Modesto, Turlock, and Extended Merced Subbasins, respectively (Table 9-12). This is larger than for LSJR Alternatives 2 and 3 because the irrigation districts would need use their expanded pumping capacity more often because of the greater reduction in surface water supply under LSJR Alternative 4.

Under LSJR Alternative 4, reduction in groundwater levels could cause a potential degradation of groundwater quality as described for LSJR Alternative 3. However, under LSJR Alternative 4, degradation of water quality could be worse because all four subbasins would be affected. For example, LSJR Alternative 4 includes groundwater impacts on the Eastern San Joaquin Subbasin, where reduced groundwater levels below Stockton have caused the migration of saline water from the west to move eastward into the basin. In some areas below Stockton, salinity concentrations in groundwater exceed drinking water standards (SEWD 2014). The rate of this intrusion of saline water could increase under LSJR Alternative 4.

The average reduction in net irrigation district groundwater balance under LSJR Alternative 4 could exceed 1 inch across the Eastern San Joaquin, Modesto, Turlock, and the Extended Merced

Subbasins. Thus, LSJR Alternative 4 could potentially substantially deplete groundwater supplies and interfere substantially with groundwater recharge and affect groundwater quality. Therefore, impacts on groundwater resources are potentially significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in changes to the impacts on groundwater resources. For reasons discussed under LSJR Alternative 3, adaptive implementation method 3 would not affect impacts associated with LSJR Alternative 4. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the February–June, 60 percent unimpaired flow requirement (to 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3 (i.e., less severe for groundwater resources, but still significant).

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Mitigation to reduce significant impacts on groundwater resources could include the State Water Board or local agencies exercising their various authorities over groundwater users, including authorities under SGMA.

As discussed in detail under LSJR Alternative 2 with adaptive implementation, the State Water Board has several authorities that are independent of SGMA but it is local agencies that are vested with the mandatory duty to achieve sustainable groundwater management, which includes not causing undesirable results such as significant and unreasonable reduction of groundwater storage and degradation of water quality. These local agencies, with authorities over Eastern San Joaquin, Modesto, Turlock, and the Extended Merced Subbasins**,** therefore, can and should exercise their full authorities to address substantial depletion of groundwater supplies and water quality degradation, both under SGMA and their police powers. Under that authority, they can and should also implement those mitigation measures identified in LSJR Alternative 2 with adaptive implementation above. Doing so would prevent groundwater depletion and water quality impacts, mitigate those impacts, or both. Due to the inherent uncertainty in the degree to which this mitigation may be implemented by local agencies, however, impacts on groundwater resources under LSJR Alternative 4, with or without adaptive implementation, would remain potentially significant and unavoidable.

As further stated under LSJR Alternative 2 with adaptive implementation, the State Water Board can and will revisit and analyze the groundwater condition during the periodic review of the water quality control plan. Where and when appropriate, it will also exercise its independent but complementary authorities under SGMA to ensure sustainable management of the groundwater basins in the plan area.

Impact GW-2: Cause subsidence as a result of groundwater depletion

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the technical analysis of the No Project Alternative.

LSJR Alternative 2 (Less than significant/Significant and unavoidable with adaptive implementation)

As described under Impact GW-1 for LSJR Alternative 2, the estimated average net irrigation district groundwater balance under LSJR Alternative 2 is predicted to be either similar to or slightly less than under baseline conditions, with the decrease being most noticeable in the Extended Merced Subbasin (Figures 9-10 through 9-13). The average reduction in annual net groundwater recharge under LSJR Alternative 2 relative to baseline is equivalent to 0.0-0.7 inches of water across each of the four subbasins (Table 9-12).

These changes are less than the 1 inch threshold for significant reduction in groundwater levels, meaning that the reduction in groundwater levels at the 20 percent unimpaired flow level is less than significant. Therefore, under LSJR Alternative 2, as compared to baseline, the slight reduction in groundwater recharge would not likely result in subsidence.

Adaptive Implementation

As described under Impact GW-1, LSJR Alternative 2 with adaptive implementation methods 2 and 4 would not affect groundwater supplies and therefore would not cause subsidence. Adaptive implementation method 3 would not be authorized under LSJR Alternative 2. However, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20 percent February-June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). If this adjustment occurs frequently or for extended durations, impacts under LSJR Alternative 2 could become more like the impacts under LSJR Alternative 3.

At the 30 percent unimpaired flow level, the impacts on groundwater would increase relative to the 20 percent unimpaired flow level (Table 9-12) and could reach the equivalent of 1.2 inches across the Extended Merced Subbasin (i.e., greater than the threshold of significance for Impact GW-1). Because portions of the Extended Merced Subbasin show evidence of subsidence (see Section 9.2.1, *San Joaquin Valley Groundwater Basin and Subbasins*), it is likely that increased groundwater depletion in the Extended Merced Subbasin could lead to increased subsidence. Subsidence in the other subbasins is less likely to occur given that there is little evidence that the soils in these subbasins are subject to inelastic compaction.

Therefore, under LSJR Alternative 2 with adaptive implementation method 1, subsidence due to a reduction in groundwater levels would potentially be significant and unavoidable.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Mitigation to reduce significant impacts on groundwater resources could include the State Water Board or local agencies exercising their various authorities over groundwater users, including authorities under SGMA.

As discussed under Impact GW-1 for LSJR Alternative 2 with adaptive implementation, the State Water Board has several authorities independent of SGMA. However, under SGMA, it is local agencies that are vested with the mandatory duty to achieve sustainable groundwater management, which includes not causing undesirable results such as significant and unreasonable reduction of groundwater storage and significant and unreasonable land subsidence that substantially interferes with surface land uses. Therefore, the local agencies with authority over the Extended Merced Subbasin can and should exercise their full authorities to address substantial depletion of groundwater supplies and subsidence, both under SGMA and their police powers. Doing so would prevent groundwater depletion and subsidence, mitigate those impacts, or both. It is possible that subsidence under LSJR Alternative 2 with adaptive implementation could be limited to areas that would not cause interference with surface land uses. However, it is unlikely that subsidence would have no effect on surface uses. Furthermore, even if subsidence did not invoke actions under SGMA, the associated depletion of the groundwater resources, as described in Impact GW-1, could invoke SGMA triggers for state interaction. Actions taken under SGMA to protect the aquifer would also protect against subsidence. However, given the inherent uncertainty in the degree to which local agencies may implement mitigation actions, the subsidence impact under LSJR Alternative 2, with adaptive implementation, would remain potentially significant and unavoidable.

As discussed under Impact GW-1 for LSJR Alternative 2 with adaptive implementation, the State Water Board can and will revisit and analyze the groundwater condition during the periodic review of the water quality control plan. Where and when appropriate, it will also exercise its independent but complementary authorities under SGMA to ensure sustainable management of the groundwater basins in the plan area.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As described under Impact GW-1, the average reduction in net irrigation district groundwater balance under LSJR Alternative 3 could exceed 1 inch across the Modesto, Turlock, and Extended Merced Subbasins (Table 9-12). As a result, LSJR Alternative 3 could potentially substantially deplete groundwater supplies in these subbasins. Because portions of the Extended Merced Subbasin show evidence of subsidence (see Section 9.2.1, *San Joaquin Valley Groundwater Basin and Subbasins*), it is likely that increased groundwater depletion in the Extended Merced Subbasin could lead to increased subsidence. Subsidence in the other subbasins is less likely to occur given that there is little evidence that the soils in these subbasins are subject to inelastic compaction.

Therefore, due to the increased likelihood of subsidence in the Extended Merced Subbasin, under LSJR Alternative 3 subsidence due to a reduction in groundwater levels would potentially be significant and unavoidable.

Adaptive Implementation

As described under Impact GW-1, LSJR Alternative 3 with adaptive implementation methods 2, 3, and 4 would not affect groundwater supplies or, therefore, cause subsidence. Adaptive implementation method 1 could cause a 10 percent increase or decrease in the specified percent of unimpaired flow. If the specified percent of unimpaired flow were changed from 40 percent to

30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively. If the adjustment occurs frequently or for extended durations, based on the modeling results for LSJR Alternative 2, with adaptive implementation method 1 incorporated (i.e., 30 percent unimpaired flow), and LSJR Alternative 4, with adaptive implementation method 1 incorporated (i.e., 50 percent unimpaired flow), impacts would remain potentially significant and unavoidable.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Mitigation to reduce significant impacts on groundwater resources could include the State Water Board or local agencies exercising their various authorities over groundwater users, including authorities under SGMA.

As discussed under LSJR Alternative 2 with adaptive implementation, local agencies vested with the mandatory duty to achieve sustainable groundwater management and authority over the Extended Merced Subbasin, can and should exercise their full authorities to address substantial depletion of groundwater supplies and subsidence, both under SGMA and their police powers. Doing so would prevent groundwater depletion and subsidence, mitigate those impacts, or both. However, given the inherent uncertainty in the degree to which local agencies may implement mitigation actions, the subsidence impacts under LSJR Alternative 3 with adaptive implementation would remain potentially significant and unavoidable.

As further stated under Impact GW-1 for LSJR Alternative 2 with adaptive implementation, the State Water Board can and will revisit and analyze the groundwater condition during the periodic review of the water quality control plan. Where and when appropriate, it will also exercise its independent but complementary authorities under SGMA to ensure sustainable management of the groundwater basins in the plan area.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As described under Impact GW-1, under LSJR Alternative 4, the average reduction in net irrigation district groundwater balance could exceed 1 inch across the Eastern San Joaquin, Modesto, Turlock, and the Extended Merced Subbasins (Table 9-12). As a result, LSJR Alternative 4 could potentially substantially deplete groundwater supplies in these subbasins. LSJR Alternative 4 could result in the greatest potential increase in groundwater pumping and reduction in recharge from the four subbasins, as compared to baseline levels (Table 9-12). Because portions of the Extended Merced Subbasin show evidence of subsidence (see Section 9.2.1, *San Joaquin Valley Groundwater Basin and Subbasins*), it is likely that increased groundwater depletion in the Extended Merced Subbasin could lead to increased subsidence. Subsidence in the other subbasins is less likely to occur given that there is little evidence that the soils in these subbasins are subject to inelastic compaction.

Therefore, due to the increased likelihood of subsidence in the Extended Merced Subbasin, under LSJR Alternative 4 subsidence due to a reduction in groundwater levels would potentially be significant and unavoidable.

Adaptive Implementation

As described under Impact GW-1, LSJR Alternative 4 with adaptive implementation methods 2, 3, and 4 would not affect groundwater supplies and therefore would not cause subsidence. Adaptive implementation method 1 could cause a 10 percent decrease in the specified percent of unimpaired flow. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3. If the adjustment occurs frequently or for extended durations, based on the modeling results for LSJR Alternative 3, with adaptive implementation method 1 (i.e., 50 percent unimpaired flow), impacts would remain potentially significant and unavoidable.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Mitigation to reduce significant impacts on groundwater resources could include the State Water Board or local agencies exercising their various authorities over groundwater users. including authorities under SGMA.

As discussed under LSJR Alternative 2 with adaptive implementation, local agencies vested with the mandatory duty to achieve sustainable groundwater management and authority over the Extended Merced Subbasin can and should exercise their full authorities to address substantial depletion of groundwater supplies and subsidence, both under SGMA and their police powers. Doing so would prevent groundwater depletion and subsidence, mitigate those impacts, or both. However, given the inherent uncertainty in the degree to which local agencies may implement mitigation actions, the subsidence impacts under LSJR Alternative 3 with adaptive implementation, would remain potentially significant and unavoidable.

As further stated under Impact GW-1 for LSJR Alternative 2 with adaptive implementation, the State Water Board can and will revisit and analyze the groundwater condition during the periodic review of the water quality control plan. Where and when appropriate, it will also exercise its independent but complementary authorities under SGMA to ensure sustainable management of the groundwater basins in the plan area.

9.4.4 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows, as described in Chapter 5, *Surface Hydrology and Water Quality*, would not impact groundwater resources. The extended plan area primarily has a shallow-to-bedrock geology. There is only one designated groundwater basin, the Yosemite Basin in Yosemite National Park in Mariposa County as the shallow-to-bedrock geology produces relatively small, localized, and isolated groundwater areas. If junior water right holders reduced their reliance on surface water diversions and extracted more groundwater to compensate for the reduction, more groundwater could be extracted over time in the extended plan area, primarily under LSJR Alternatives 3 and 4 with or without adaptive implementation. However, this extraction would be small based on the relatively small amount of consumptive use that occurs in the extended plan area. Thus, impacts would be less than significant in the extended plan area.

9.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 10
Recreational Resources and Aesthetics

10.1 Introduction

This chapter describes the environmental setting for recreational resources and aesthetics (e.g., visual character and quality), and the regulatory background associated with recreational resources and aesthetics. This chapter also evaluates environmental impacts on recreational resources and aesthetics that could result from the Lower San Joaquin River (LSJR) alternatives and, if applicable, offers mitigation measures that would reduce significant impacts.

Recreationists enjoy a variety of water-dependent and water-enhanced activities in the plan area. As described in Chapter 1, *Introduction*, the plan area generally includes those portions of the San Joaquin River (SJR) Basin that drain to, divert water from, or otherwise support beneficial uses of water associated with, the three eastside tributaries[1] of the LSJR. This area includes the Stanislaus, Tuolumne, and Merced Rivers; the rim dams[2] and major reservoirs on each river; the LSJR; and southern Delta waterways.

The extended plan area, also described in Chapter 1, generally includes the area upstream of the rim dams. The area of potential effects for this area is similar to that of the plan area and includes the zone of fluctuation around the numerous reservoirs that store water on the Stanislaus and Tuolumne Rivers. (The Merced River does not have substantial upstream reservoirs.) It also includes the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Resources Control Board (State Water Board) determined whether the plan amendments[3] would cause any adverse impact on resources in each of the listed environmental categories and provided a brief explanation for its determination. Impacts in the checklist that are identified as "Potentially Significant Impacts" are discussed in detail in this chapter. In Appendix B, the State Water Board determined that the impacts of the LSJR alternatives on recreational resources, as listed in the checklist, are either "Less than Significant" or "No Impact." However, as discussed in Appendix B, the State Water Board determined that other types of potential adverse impacts on recreational resources that are not in the checklist should be evaluated. Accordingly, this chapter evaluates impacts not explicitly identified in the checklist but that have been identified in Appendix B as potentially significant. This chapter evaluates whether the LSJR alternatives would substantially physically deteriorate existing recreation facilities on the rivers or at reservoirs. Appendix B also identified the LSJR alternatives as having a potentially significant impact on aesthetics because of the potential to substantially degrade the existing visual character or quality at reservoirs and its surroundings.

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[1] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[2] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

[3] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

The impact analysis in this chapter focuses on changes in surface water elevations that could degrade the existing visual character or quality of the reservoirs. In addition, this chapter addresses whether a substantial adverse effect on scenic vistas or substantial damage to scenic resources within a state scenic highway in the extended plan area would occur.

Recreational and aesthetic impacts in this chapter for the plan area are generally evaluated using the change in the frequency of acceptable average recreation seasonal flow and reservoir elevation level conditions between May and September. For rivers, changes in the volume flow are used to evaluate whether recreational facilities would substantially deteriorate and in-river activities would be significantly reduced. For reservoirs, reservoir elevation levels are evaluated by identifying changes during drier years to present a conservative analysis of the potential recreational and aesthetic impacts that could occur under the LSJR alternatives. This is done by evaluating changes in modeled results at the 30 percent cumulative distribution, representing the lowest one-third of reservoir elevation levels, which represents low elevation conditions typically experienced under drought or dry conditions. For the extended plan area, recreational and aesthetic impacts are generally addressed qualitatively by addressing potential changes to existing resources under the LSJR alternatives, particularly during drought periods.

As discussed in Appendix B, the southern Delta water quality (SDWQ) alternatives are not anticipated to adversely affect recreational resources or aesthetics in the southern Delta because water quality in the southern Delta is expected to remain within historical ranges (see Chapter 5, *Surface Hydrology and Water Quality*). Furthermore, any changes in salinity levels within historical ranges are expected to be imperceptible to recreationists. Therefore, the effects of the SDWQ alternatives are not analyzed further in this chapter. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on recreational resources or aesthetics. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

The potential impacts of the LSJR alternatives on recreational resources and aesthetics are summarized in Table 10-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3 and 4 each include four methods of adaptive implementation. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 10-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR/SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to actions and methods of compliance.

Table 10-1. Summary of Recreational Resources and Aesthetics Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact REC-1: Substantially physically deteriorate existing recreational facilities on the rivers or at the reservoirs			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Significant	NA
LSJR Alternative 2	Under LSJR Alternative 2, modeled flows are not expected to cause substantial physical deterioration of on-bank recreational facilities because the seasonal average frequency of river flows (cubic feet per second [cfs]) would not change substantially from baseline. Modeled flows would also not affect in-water recreational activities because they would not change significantly from baseline. Under LSJR Alternative 2, there would be relatively small changes in reservoir elevations. These changes would not substantially deteriorate existing recreational facilities at the reservoirs because all boat ramps and other facilities would remain available to recreationists.	Less than significant	Less than significant
LSJR Alternative 3	Modeled frequencies of flows greater than 2,500 cfs would change little on the Merced and Stanislaus Rivers, and therefore on-bank recreational facilities would not experience substantially more inundation relative to baseline conditions. However, flows greater than 2,500 cfs would increase in frequency on the Tuolumne River in May and June, but would remain close to baseline values July – September. Although the flows on the Tuolumne River could result in an increase in the frequency of inundation of on-bank recreation areas during May and June, recreational facilities are not anticipated to substantially physically deteriorate along the river. On-bank recreational facilities are built to withstand periodic inundation with higher river flows. The modeled seasonal average frequency of low flows (less than 500 cfs) on the Merced and Tuolumne Rivers would decrease more than 10% relative to baseline conditions. However, during July-September, the most popular recreational months for the three eastside tributaries, the frequency of low flows would change by less than 10% relative to	Less than significant	Significant and unavoidable[c]

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	baseline for the three eastside tributaries. Therefore, this alternative is not anticipated to affect in-water activities, with or without adaptive implementation. The change in reservoir elevations under LSJR Alternative 3 would not significantly affect recreation at New Melones Reservoir or Lake McClure. It is expected that there would be a substantial decrease in elevation of New Don Pedro Reservoir. However, because all boat ramps in New Don Pedro Reservoir would remain operable at the 30% cumulative distribution elevation (e.g., dry years), and because some boat ramps in New Don Pedro Reservoir are still operable at minimum reservoir elevations, there would be no physical deterioration nor reduction in the use of existing recreation facilities at this location. If adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 40% up to 50%), it is expected that the modeled seasonal average frequency of river flows above 2,500 cfs on the Tuolumne River would greatly increase, especially during May and June. The frequency of inundation of on-bank facilities on the Tuolumne River and, to a lesser extent, on the Stanislaus River is expected to increase compared to baseline. Accordingly, LSJR Alternative 3, with the incorporation of adaptive implementation method 1, would cause substantially deterioration of existing recreational facilities.		
LSJR Alternative 4	There would be a substantial increase in flows above 2,500 cfs on the Tuolumne and Stanislaus Rivers under LSJR Alternative 4, with or without adaptive implementation. Although on-bank recreational facilities are built to withstand periodic inundation, facilities may substantially physically deteriorate from the expected significant increase in inundation frequency relative to baseline. The modeled seasonal average frequency of low flows on the Merced and Tuolumne Rivers, without adaptive implementation, would decrease more than 10%. The decrease is mostly due to low flow reduction in May and June. However, because there would be little	Significant and unavoidable	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	change in low flows on the Stanislaus, Tuolumne, and Merced Rivers relative to baseline during the warmest months in the San Joaquin Valley when swimming and wading are most popular (July–August), the reduced opportunity for swimming and wading on the three eastside tributaries in May, and particularly in June (i.e., early in the summer recreational season), is not expected to substantially reduce recreational use for the season. Seasonal average elevations at Lake McClure and New Melones Reservoir are expected to increase. The seasonal average elevation at New Don Pedro Reservoir is expected to decrease at the 30% cumulative distribution elevation. Decreased reservoir levels at New Don Pedro Reservoir would not substantially physically deteriorate existing recreation facilities at the reservoirs (marinas and boat ramps), and all boat ramps would remain operable. There would be no reduction in use of the facilities at New Don Pedro Reservoir. Therefore, given the significant increase in the modeled frequency of high seasonal average flows (greater than 2,500 cfs) on the Stanislaus and Tuolumne Rivers associated with LSJR Alternative 4, with and without adaptive implementation, substantial physical deterioration of existing recreational facilities is expected.		
Impact REC-2: Substantially degrade the existing visual character or quality of the reservoirs			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Significant	NA
LSJR Alternative 2	Under certain conditions, reservoir elevations at Lake McClure and New Melones Reservoir could increase and could result in an improvement to the existing views. The expected decrease in reservoir elevation at New Don Pedro Reservoir would not result in a substantial degradation of existing visual character or quality.	Less than significant	Less than significant
LSJR Alternatives 3 and 4	Under certain conditions, reservoir elevations would increase at Lake McClure and New Melones Reservoir and could improve the existing views.	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	At New Don Pedro Reservoir, decreases in water surface elevation during some dry years could cause a substantial degradation of existing visual character or quality; however, views at this location are Class III, and changes to the character of the landscape can be moderate without compromising visual quality.		

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 10.4.2, *Methods and Approach,* of this chapter.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives identified in the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan). See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

[c] Implementing adaptive implementation method 1, on a more frequent basis can result in a change in the impact determination for LSJR Alternative 3, as summarized in this table, and described in detail in Section 10.4.3*, Impacts and Mitigation Measures*, of this chapter.

10.2 Environmental Setting

There are three distinct environments for water-based recreation on the Stanislaus, Tuolumne, and Merced Rivers, the LSJR, and the southern Delta: flowing rivers, controlled reservoirs, and open (i.e., tidal) Delta waterways. Recreation takes place in managed facilities, at informal access points, and in undeveloped areas. Much of the recreation use is water dependent (e.g., boating, swimming), but many other popular activities (e.g., camping, hiking) are simply enhanced by the presence of water. Recreational opportunities have been substantially influenced by the construction of reservoirs and the management of the water levels in those reservoirs and the resulting effect on river flows.

Typical recreational activities in the watersheds include: boating, fishing, swimming, water sports, horseback riding, hiking, biking, camping, picnicking, birding and nature viewing, hunting, and gold panning. Facilities constructed throughout the plan area permit similar recreational uses (e.g., boat-based fishing, kayaking, beach swimming, picnicking), although the spectrum of uses may shift depending on conditions. Swimming is more common in the reservoirs but may also occur on the rivers during low flows. Boating activities, such as whitewater rafting, kayaking, and canoeing, are popular on the rivers. Preferred recreational activities change with time, reflecting the current economic and cultural conditions. For example, undeveloped areas in the plan area, such as wildlife preserves, were once widely used for hunting, but are now becoming increasingly popular for other uses, such as nature viewing and bird watching (USBR 1999).

The existing recreational uses of the LSJR, its three eastside tributaries, the reservoirs at the rim dams, and the southern Delta are described below.

10.2.1 Rivers

Flows in the LSJR and eastside tributaries are regulated by the rim dams. Different ranges of flow releases from storage[4] support different recreational uses and facilities along the rivers. These flows also contribute to the aesthetic characteristic of the landscape in which they are located. The LSJR and eastside tributaries are generally characterized by a river channel flanked with a narrow ribbon of riparian vegetation, complemented in some areas by larger wildlife preserves and parks, and interrupted by agricultural development and urbanization. The viewsheds are variable, but unified by the natural aspect of the rivers and the interface with either the natural or augmented landside. Due to the variability of rivers and the dynamic shoreline, viewers are generally less sensitive to changes in river height, and are affected primarily by severely high or low flows. Details regarding the different recreational uses of the Stanislaus, Tuolumne, and Merced Rivers and the LSJR are discussed below.

Merced River

The lower reach of the Merced River, from below McSwain Dam to the river's confluence with the LSJR, is 50 miles long and crosses private agricultural and grazing land in Merced County. This reach of the Merced River includes contact water recreation (e.g., swimming, wading, water skiing, and fishing) and non-contact water recreation (e.g., hiking, picnicking, and boating) as designated beneficial uses (State Water Board 1998).

Major public recreation facilities on this river reach include Henderson County Park on Merced Falls Road east of Snelling, McConnell State Recreation Area (SRA) northeast of Livingston on State Route 99, Hagaman County Park at the State Route 165 river crossing, and George J. Hatfield SRA on Kelley Road near the LSJR confluence. The county parks are primarily day-use facilities, while the SRAs provide both day-use and camping areas (USBR 1999). The county parks do not have boat launch ramps, and they do not allow swimming because lifeguards are not present. Approximately 73,000 water-related visitor days are spent on the Merced River annually (USBR 1999). The Merced River is largely surrounded by private land, which limits the opportunities for public access (Merced ID 2011a).

Water-dependent activities include some canoeing and rafting in the lower portion of the river. Water-enhanced activities include picnicking, and camping (USBR 1999). Boat-based fishing is popular between the Merced Falls Dam and the Crocker–Hoffman Diversion Dam, especially during high flows. Generally, flows below 500 cubic feet per second (cfs) are considered too low for boating. Flows are currently below 500 cfs approximately 83 percent of the time in the summer months. Popular sport fish that are found in this stretch of the Merced River include catfish and smallmouth bass (USBR 1999).

Kayaking, rafting, and canoeing take place on the lower Merced River at flows of 250–3,200 cfs. In a study conducted in the winter of 2010, the boaters surveyed indicated that while the river's reach was floatable at the winter low flow levels down to 250 cfs, they would not likely return to boat the

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[4] In this document, the term *releases from storage* means water is released from the reservoir.

Merced River because the flow did not provide a quality boating opportunity at that flow level (Merced ID 2011b). Overall, the boaters surveyed in the study identified a boatable flow range for canoes and kayaks of roughly 570 to 2,000 cfs (Merced ID 2011b). For kayakers and rafters, flows of approximately 300–350 cfs are considered appropriate for beginners, while high flows of 1,200-3,200 cfs are considered advanced (American Whitewater 2012).

During lower flows in the fall and winter, wading is more popular (Merced ID 2011b). Optimal flow ranges on the Merced River for swimming are 50–200 cfs (USBR 2001).

Tuolumne River

The lower Tuolumne River, from New Don Pedro Dam to the river's confluence with the LSJR, is approximately 52 miles long. This reach of the Tuolumne River includes contact and non-contact water recreation as designated beneficial uses (State Water Board 1998). This reach traverses mainly private open space and grazing lands, City of Modesto property, and several public parks; therefore, access to the river is limited.

Existing recreation facilities include: La Grange County Regional Park, Fox Grove County Regional Park, Riverdale, two golf courses adjacent to the river near the State Route 99 crossing, and the Shiloh fishing access. In addition, the Turlock SRA and Modesto Reservoir Regional Park provide camping facilities. There is also public access to the river at the Tuolumne River Regional Park near Modesto (San Joaquin River Partnership 2012).

Common water-dependent recreational activities on the Tuolumne River include boating, fishing, swimming, and rafting. Together with wildlife viewing, 150,000 visitor days were spent conducting these water-dependent recreational activities in 1992 (USBR 1999). Rafting season is generally April–October. The optimal flow for rafting is 300 cfs (TID and Merced ID 2011). Boating season on the lower Tuolumne River is typically May–October. The lowest boatable flow on the upper reaches of the lower Tuolumne River ranges from 100–150 cfs (TID and MID 2013a). Drift boaters and rafters identified the lower Tuolumne as unboatable at 150 cfs. Recent daily average flow data collected at the La Grange gage indicated flows were at or above 150 cfs approximately 84 percent of the time, and during the boating season flows were at or above 150 cfs 98 percent of the time in May and 56 percent of the time July–September (TID and MID 2013a).

Stanislaus River

The lower Stanislaus River runs 60 miles from the New Melones Dam to the river's confluence with the LSJR, crossing primarily private agricultural and grazing lands in Tuolumne, Stanislaus, and San Joaquin Counties (see Chapter 11, *Agricultural Resources*). This reach of the Stanislaus River includes contact and non-contact water recreation as designated beneficial uses (State Water Board 1998).

The Stanislaus River has numerous park facilities, many used for water-dependent activities, such as boat launching, fishing, camping, swimming, as well as water-enhanced activities, such as picnicking or camping. Parks include Knights Ferry Recreation Area, Horseshoe Park, Orange Blossom Park, Valley Oak Recreation Area, Oakdale Recreation Area, Jacob Meyers Park, McHenry Recreation Area, and Caswell Memorial State Park. There is also public access to the river at numerous road crossings. In 1999, there were an estimated 330,217 recreational visitor days spent on the Stanislaus River (McAfee 2000).

Water-dependent activities practiced on the Stanislaus River include fishing, swimming, and whitewater boating (rafting and kayaking). Popular sport fish found in this stretch of the Stanislaus River include catfish, crappie, largemouth bass, and smallmouth bass. Boating activities on the Stanislaus River generally take place when the flow is 25–1,200 cfs (Dreamflows 2011). Flows of 500 cfs–3,000 cfs can allow for advanced rafting and kayaking (All Outdoors 2011). Access to an advanced, 4-mile whitewater boating run is provided below Goodwin Dam (USBR 1999). Extensive boating use on the lower Stanislaus River has contributed to eroding beaches, excessive noise, trespassing, and other issues that degrade recreating visitor experiences (McAfee 2000).

Lower San Joaquin River

Public access to the LSJR is available at several road and highway crossings. Stanislaus County recreation facilities on the LSJR include the Las Palmas fishing access site and Laird County Park (USBR 2001). In addition, there is Durham Ferry SRA in San Joaquin County, and the San Joaquin National Wildlife Refuge between the Stanislaus and Tuolumne River confluences (San Joaquin River Partnership 2012). Most of the use of these recreational areas is assumed to come from the local counties (USBR 1999).

The LSJR includes contact and non-contact water recreation as designated beneficial uses (State Water Board 1998). An estimated 157,000 visitor days are spent boating and fishing in the LSJR annually (USBR 2001). Popular sport fish that occur in this stretch of the SJR include catfish and smallmouth bass (USBR 1999). Water-enhanced shore activities include picnicking and other activities.

The optimal flow range for non-motorized boating activities on the LSJR has been estimated to be 300-500 cfs, while motorized boating may occur at flows up to 750 cfs (USBR 1997; Frago pers. comm.). However, characterizing the optimal flows for recreation on the LSJR is much more complex than for the three eastside tributaries. This is due to the river’s variability in flow within the plan area; flow increases at each river confluence. South of the Merced River confluence, the river has been nearly dry at times in recent years, while summer flows in the SJR at Vernalis range between about 1,000 cfs in dry years to more than 10,000 cfs in wet years. The monthly median flows at Vernalis range between 5,000 cfs in the spring (May) and 2,000 cfs in the late summer (August and September).

10.2.2 Reservoirs

Peak visitation of California reservoirs is generally in the drier months of May through August. Recreational opportunities on and near the reservoirs are influenced by water levels; therefore, the manner in which a reservoir is operated directly affects visitor use and the quality of the recreational experience. Reservoir operations for water supply are usually adequate to support established recreation activities and facilities, particularly when surface runoff from precipitation is near normal. Recreation facilities, such as beaches, boat ramps, trails, restrooms, access roads, picnic areas, and camping facilities add to the quality of the recreation experience. Lower reservoir levels, however, result in water surface receding far from developed recreation facilities, such as campgrounds, picnic areas, and swimming beaches. Boat ramps, docks, and swimming areas become unusable if they are no longer submerged or are no longer close to the water. Declining surface area affects boating and water skiing and reduces aesthetic values. Recreation attendance decreases when water levels drop well below major recreation facilities and boat ramps. During the 1976-1977 drought, total attendance at state and federal reservoirs in California decreased approximately 30 percent, with some reservoirs experiencing declines of as much as 80 percent. Attendance at a few stable reservoirs actually increased. A similar pattern developed during the

1987–1992 drought, although there were even fewer stable reservoirs (DWR 1994). Viewers (e.g., recreationists) of the reservoirs experience both a managed aesthetic (e.g., changes in water elevation levels as a result of reservoir operation) and a natural aesthetic (e.g., surrounding forest and mountains). Generally, those participating in recreational activities in and around reservoirs are likely to highly value the natural environment, appreciate the visual experience, and be sensitive to changes in visual character and quality.

Lake McClure

The New Exchequer Dam impounds the Merced River, forming Lake McClure. The reservoir's visual character and quality is that of both a natural environment (e.g., surrounding forest and mountains) and a managed environment (e.g., recreation and hydropower facilities).

Generally, the surrounding area view is of the Sierra Nevada and includes low rolling hills and rugged mountains, with differing trees and vegetation bordering the reservoir. The dominant visual elements are the hills, ridges, small valleys, and patterns created by the vegetation on the hills and the surface of the water. The vegetative patterns are influenced by a combination of soil types, aspect, and fire history. The hills are occasionally accented by steep canyon walls. Native vegetation transitions to nonnative plants and trees in a few residential and more developed areas.

The managed environment in the vicinity of the reservoir presents varying visual contrast when compared to the natural environment that surrounds and extends beyond the reservoir. There are two-lane roads and highways around the reservoir that afford views of the mountains, trees, and reservoir. The Highway 49 Bridge, Lake McClure, and part of Bagby Recreation Area can be seen from the Highway 49 vista point just north of the bridge. The Sierra Nevada foothills are taller and more dramatic in this area than other areas around the reservoir, and the vegetation is similar to other areas around the reservoir. The New Exchequer Dam, support buildings, and spillway present a strong visual contrast relative to the natural landscape due to the geometric shapes and light colors. The New Exchequer Dike presents moderate visual contrast due to the gray tones and rough texture of the rock facing of the structure (Merced ID 2014).The small footprint of the Bagby Boat Launch facility presents a weak visual contrast to the surrounding natural landscape. The road presents strong visual contrast when compared to the natural surroundings due to the shape, texture, and color of the road (Merced ID 2011a).Low water elevations in the reservoir create a strip of bare land around Lake McClure that is sparse in vegetation, creating a strong visual contrast with the natural surroundings (Merced ID 2014).

Residential and recreational structures contrast with the surrounding foothill and mountain scenery. These rural developed areas are within close proximity of the reservoir and include towns and primary road networks; however, the setting is pastoral or rural because of interspersed forests, water resources, hills, and valleys.

The shoreline edges along the reservoir appear natural and include vegetation and land and water interface; however, these edges also exhibit unnatural features, such as human-made facilities (e.g., water control structures and recreation facilities) and large bands of exposed soil. Recreation facilities are prevalent around the shoreline edges of the reservoir, including boat docks, beaches, campgrounds, and marinas, all of which are also considered a contrasting visual quality to the surrounding natural setting of the Sierra Nevada foothills and mountains. There is no vegetation at the shoreline, which is characteristic of the shore/water interface given the daily, monthly, and seasonal fluctuations in water elevation (USBR 2007; USBR 2011a).

Lake McClure recreation facilities include 4 developed areas (McClure Point, Barrett Cove, Horseshoe Bend, and Bagby), with 530 camping units, 5 boat launch facilities, 2 marinas, 62 picnic units, and fish cleaning stations. Day-use facilities include sandy beaches and swim lagoons, most in grassy park-like settings with group facilities and play equipment (DWR 2001). The recreation facilities are owned and operated by Merced Irrigation District's (Merced ID) Parks Department, with the exception of two small areas within McClure Point Recreation Area and Horseshoe Bend Recreation Area that are owned by the U.S. Bureau of Land Management (BLM).

Outside of the four public access areas on Lake McClure, the remainder of the land surrounding the reservoir is private (Merced ID 2011a). Since most of the undeveloped reservoir shoreline is relatively far from roads and the shoreline is irregular and steep, little recreational activity occurs there (DWR 2001). Lake McSwain is a small reservoir located about 3 miles downstream of the New Exchequer Dam. Lake McSwain offers adjacent recreational opportunities.

Recreational activities on Lake McClure and McSwain Reservoir include camping, boating, swimming, hiking, bicycling, houseboating, and fishing. In 2010, nearly 1.4 million visitor days were spent on Lake McClure, and approximately 482,000 visitor days were spent on McSwain Reservoir (Merced ID 2014). Lake McClure is popular with water skiers because the surrounding tree covered hills protect the reservoir from the prevailing westerly winds (DWR 2001). In 2010, an average of 100 watercraft were reported on Lake McClure at one time (0.01 watercraft per acre), 94 percent of which were motorized (Merced ID 2011a). Recent surveys conducted by Merced ID have indicated that most visitors to Lake McClure are local (Merced ID 2011a).

Modeled reservoir elevation has ranged between approximately 865 feet (ft) mean sea level (MSL) and 635 ft MSL. Therefore, reservoir elevations during drought years can be 230 ft below the historical maximum elevation. Historically, the monthly average elevation of the reservoir has ranged from a minimum of 755 ft MSL in October to a maximum of 810 ft MSL in June. Boat access is provided at ramps located around the shoreline. Lake McClure boat ramps cease operation when reservoir elevation is 590–793 ft MSL. The ramp at Bagby is the first to close when the reservoir decreases to an elevation of 793 ft MSL, followed by Horseshoe Bend at 758 ft MSL, McClure Point at 650 ft MSL, southern Barrett Cove at 630 ft MSL, and northern Barrett Cove and Piney Creek, both at 590 ft MSL (USBR 1999). Reservoir visitors report that the current water levels in the reservoir are acceptable but can sometimes cause degraded scenery (Merced ID 2011a).

New Don Pedro Reservoir

The New Don Pedro Dam impounds the Tuolumne River, forming the New Don Pedro Reservoir. Generally, the visual character and quality that recreationists and others experience around the New Don Pedro Reservoir is similar to that described for Lake McClure. Numerous long expanses of flat water that stretch through a series of narrow valleys and inlets characterize New Don Pedro Reservoir's visual setting. Similar to Lake McClure, the Sierra Nevada foothills surround the reservoir, rising gradually from its shoreline to grant wide and open views. There are very few buildings in the vicinity of the reservoir. Views are not urban or suburban in nature. Two-lane roads and highways provide views of the mountains, trees, and water.

The largely tree-covered hillsides are interspersed with grassland areas that remain unvegetated during the dry summer months. As the water level falls, an unvegetated ring around the entire reservoir is clearly visible (San Francisco Planning Department 2007). Where the slopes are steeper, sandy brown soils are exposed. In some locations, the drawdown exposes large rocky areas which tend to match rocky areas above the high water mark and present little visual contrast. As the reservoir elevation gets lower and the drawdown zone expands, the visual lack of vegetation emphasizes a strong visual contrast between the natural, vegetated hillside and the exposed hillside (TID and MID 2013b). New Don Pedro Reservoir provides 160 miles of shoreline and 13,000 acres of surface area at maximum reservoir level. The reservoir has hiking trails, two marinas, a swimming lagoon, and 559 campsites in three locations (Fleming Meadows Recreation Area, Blue Oaks Recreation Area, and Moccasin Point Recreation Area). Outside of the three developed recreation areas, there is boat-in access to much of the shoreline and to the islands within the reservoir for dispersed use, including day use and primitive camping. The recreation facilities are operated by the Don Pedro Recreation Agency (DPRA), which is a department within Turlock Irrigation District (TID). The Modesto Irrigation District (MID) and the City and County of San Francisco (CCSF) sponsor the DPRA. The primary objective of the DPRA is to provide a quality family camping experience and a water sports-oriented environment (TID and Merced ID 2011).

The maximum reservoir elevation is 830 ft MSL. The monthly average elevation of the reservoir has ranged from a low of 750 ft MSL in October to a high of 790 ft MSL in June. The minimum elevation, recorded during a drought period, was 630 ft MSL. Therefore, the reservoir elevations can vary by approximately 200 ft. Boat launches are available at the Fleming Meadows campsite until the reservoir elevation drops below 600 ft MSL. The boat launches at Moccasin Point and Blue Oaks are usable above 722 ft MSL and 726 ft MSL, respectively. Boating activity on the reservoir declines at reservoir levels of 790–750 ft MSL (USBR 1999).

The maximum recreation capacity of New Don Pedro Reservoir is 500,000 visitor days annually (Barnes 1987). Peak recreation season is typically April–September. In 2012, the total recreation visitor use days during peak season was approximately 244,000. The highest use occurred during July, with nearly 87,000 recreation visitor use days (TID and MID 2013a). During the 2012 off-season (November–March), there were a total of 18,248 visitor use days, with fewer than 6,000 recreation visitor use days each month (TID and MID 2013a).

New Melones Reservoir

The New Melones Dam impounds the Stanislaus River, forming the New Melones Reservoir. New Melones Reservoir is relatively large with a varied geography that promotes many types of recreation. Generally, the visual character and quality of the reservoir is similar to that of Lake McClure and New Don Pedro Reservoir. The visual setting includes views of mountains and pine forest interspersed with grasslands. The shoreline is modified with recreational facilities.

The seasonal reservoir drawdown can result in an area of exposed soil with little or low-growing vegetation around the shoreline. Where the slopes are steeper, reddish brown soils are exposed; and where slopes are gentler, more grasses and low vegetation tend to become established. This view, typically experienced in summer, is exacerbated during periods of low precipitation and drought. The reservoir provides approximately 12,500 acres of surface area at capacity for recreation and supports approximately 800,000 visitor days annually (USBR 2011b). There are six recreation areas on New Melones Reservoir. The Mark Twain, Parrot's Ferry, Camp Nine, and Old Town areas are relatively undeveloped and offer few recreation facilities. The remaining recreation areas, Glory Hole and Tuttletown, offer the most structured visitor experience and are the most visited, with approximately 750,000 annual visitor days (McAfee 2000). The Glory Hole Recreation Area has two campgrounds with a total of 144 campsites, three day-use areas, hiking and biking trails, swim beaches, two boat launch ramps, and a marina with a store. The Tuttletown

Recreation Area has three campgrounds with a total of 161 campsites, two day-use areas, a boat ramp, and a visitor's center. USBR operates all recreation facilities on New Melones Reservoir.

Many recreational activities take place at New Melones Reservoir. Hunting is permitted on all of USBR's lands surrounding the reservoir, with the exception of Tuttletown and Glory Hole, but mostly takes place within or near the Peoria Wildlife Management Area. Bank fishing and gold panning takes place along the shoreline. Hiking, bicycling, and horseback riding are conducted on the approximately 25 miles of trails surrounding the reservoir. There are also several caves near the reservoir, and many visitors are involved in spelunking, or caving, in the handful of caves open to the public. The most frequented caves are the two Natural Bridges located within the Coyote Creek tributary (USBR 2007).

The average elevation of the reservoir has typically ranged from 948 ft (in October) to 973 ft (in March and June).Therefore, average seasonal drawdown is 25 ft. The minimum reservoir elevation was recorded at 712 ft MSL (July–November). The maximum reservoir elevation, typically recorded in June, is 1,085 ft MSL. Minimum reservoir elevations are below the lowest boat launch facilities. With the exception of the boat ramp at Glory Hole, all boat ramps become inoperable at reservoir elevations below 950 ft MSL. The Glory Hole boat ramp is a 2-lane facility that provides boat access at a reservoir elevation as low as 860 ft MSL. The optimal water level for recreational use of the reservoir is 950–980 ft MSL (State Water Board 1999). In the recreation areas used for camping, visitation tends to follow reservoir surface levels, declining when water levels are low. However, other recreational uses of the reservoir, such as boating and kayaking, increase when water levels recede (McAfee 2000). Prior to construction of the New Melones Dam, whitewater rafting was popular in what is now the northern portion of the reservoir near Camp Nine. This area is still rafted and kayaked when reservoir water levels are low and flow returns to the exposed channel, such as in drought years.

Tulloch Reservoir

The Tulloch Reservoir, located less than a mile downstream of the New Melones Dam, provides additional recreational opportunities. The Tulloch Reservoir is owned by the Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID). Private development is extensive around the perimeter of the reservoir. Public access to the water is provided through two privately owned marinas, South Shore Campground and Marina in Tuolumne County, and Lake Tulloch Resort in Calaveras County. Private residences and private parks operated by housing developments provide additional access to the water (OID and SSJID 2008).

Tulloch Reservoir provides 1,260 acres of surface water for recreation. The surface elevation remains fairly constant, but the reservoir is regularly lowered by approximately 10 ft in the winter to provide space for flood control releases from New Melones Reservoir (OID and SSJID 2008).

10.2.3 Extended Plan Area

In general, views of the rivers in the extended plan area include features of the surrounding landscape, such as hills, mountains, valleys, vegetation, and other natural resources. Urban and suburban features are limited, and typically views of the natural landscape are uninterrupted with buildings or infrastructure. The Stanislaus National Forest comprises a large portion of the extended plan area. The extended plan area covers large parts of Calaveras, Tuolumne, and Mariposa Counties. These counties are primarily rural in nature and are characterized by rolling foothill and/or steep mountainous terrain, very low population density, and an attractive and unspoiled natural environment.

Reaches of the Tuolumne and Merced Rivers in the extended plan area are classified as wild and scenic (see Section 10.3.1, *Federal [Regulatory Background]*, for more information about the National Wild and Scenic Rivers Act); the Stanislaus River in the extended plan area is not classified as wild and scenic (National Wild and Scenic Rivers System 2016). A total of 122 miles of the Merced River is designated, with 71 designated as wild, 16 designated as scenic, and 35.5 miles designated as recreational. A total of 83 miles of the Tuolumne River is designated with 47 miles designated as wild, 23 miles designated as scenic, and 13 miles designated as recreational. Both rivers generally offer recreationists and other viewers uninterrupted views of the natural landscape that consist of glaciated peaks, lakes, and alpine and subalpine meadows. Depending on the location in the extended plan area, there are also uninterrupted and extensive views of the Merced and Tuolumne Rivers. Flows on the Merced River are generally not controlled by reservoirs because there are no major reservoirs on the Merced River in the extended plan area. Since the Merced River is relatively free-flowing, flows are primarily influenced by weather patterns including winter snow accumulation, spring and summer snowmelt, and summer precipitation (Dettinger et al. 2004; Yosemite National Park 2013). Flows on the Tuolumne River are highly regulated, primarily by releases from the Hetch Hetchy Reservoir, and viewers are subjected to these regulated flows (National Wild and Scenic Rivers System 2016.) Although the Stanislaus River is not identified as wild and scenic, flows are also highly regulated by releases from large reservoirs, such as Spicer Meadow, Donnell, and Beardsley Reservoirs, and viewers are subjected to these regulated flows.

There are several designated scenic highway routes in the extended plan area, including State Route 4, State Route 140, and State Route 120 (Caltrans 2016). One of the largest viewer groups affected by changes along a state scenic highway is the travelers along the roadways. Many of the roadways in close proximity to the reservoirs and along the rivers serve as commercial and commuter routes, as well as scenic routes used by recreationists. Viewers who frequently commute via these roadways generally have low visual sensitivity to their surroundings. The passing landscape becomes familiar, and their attention is typically focused elsewhere. At standard roadway speeds, views are fleeting, and travelers are more aware of surrounding traffic, road signs, the automobile's interior, and other visual features of the environment. However, these roadways also may be traveled for their scenic qualities, and recreational travelers on such roadways are likely to have moderate sensitivity because they seek out such routes for their aesthetic viewsheds. Therefore, viewers traveling along state-designated scenic highways for recreational purposes are considered moderately sensitive to the views they experience because these views typically are comprised of specific aesthetic resources (e.g., landscapes with variable topography, trees, rocks and rivers). A highway may be designated scenic depending upon how much of the natural landscape can be seen by travelers, the scenic quality of the landscape, and the extent to which development intrudes upon the traveler's enjoyment of the view. The designated routes and their general visual character and quality are summarized below.

- State Route 4 (also known as Ebbetts Pass Highway) is officially designated as a State Scenic Highway and a National Scenic Byway for approximately 56 miles in Calaveras and Alpine Counties in the extended plan area (Caltrans 2016; DOT 2016). It extends northward from Calaveras County, east of Arnold, to the Alpine County line, and then to State Route 89 (Caltrans 2016). This route traverses through forests of aspen, cedar, pine, fir, and tamarack; across high mountain meadows; around glacial lakes; and along mountain streams as it winds its scenic way above the canyon of the North Fork of the Stanislaus River (Caltrans 2016.). Throughout the length of the route are a number of spectacular vistas of far-off mountain peaks with intervening canyons plunging several thousand ft below the highway (Caltrans 2016.). Given the uninterrupted and relatively intact natural landscape and the sweeping views that can be experienced by drivers this route offers viewers a relatively high visual quality experience.

- State Route 140 is officially designated as a State Scenic Highway for approximately 27 miles in Mariposa County in the extended plan area (Caltrans 2016). It extends northward from the Mariposa Town planning area to the west boundary of the El Portal town planning area (Caltrans 2016). It climbs from oak woodlands in the Sierra foothills through the scenic and historic Merced River Canyon to Yosemite National Park (Caltrans 2016). Similar to Route 4, this route offers viewers a relatively high visual quality experience.
- State Route 120 is officially designated as a Connecting Federal Highway and National Scenic Byway in Mariposa County (County of Mariposa 2006). This route is within Yosemite National Park and offers views of Merced River Canyon and the park. Similar to State Routes 4 and 140, this route also offers viewers a relatively high visual quality experience.

There are two eligible scenic highways in the extended plan area: State Routes 49 and 108. State Route 49 extends through Calaveras, Tuolumne, Marisposa, and Madera Counties within the general proximity of the Stanislaus River, New Melones Reservoir, and Tulloch Reservoir; the Tuolumne River and New Don Pedro Reservoir; and the Merced River, Lake McClure, and New Exchequer Dam (Caltrans 2011). The eligible portion of State Route 49, traveling from north to south, begins in Calaveras County, crosses New Melones Reservoir, the Tuolumne County line, the Tuolumne River as the river enters New Don Pedro Reservoir, the Merced River as it enters Lake McClure, and extends to the southern Mariposa County line (Caltrans 2011). Views available to viewers using the roadway generally consist of the eastern Sierra Nevada, comprised of variable topography (mountains, hills, valleys, meadows), trees, rocks, etc. Some rural residential buildings are interspersed along this route along with small towns. The following reservoirs and rivers are visible as the road crosses them: New Melones Reservoir in Calaveras County, Tuolumne River in Tuolumne County, and the Merced River in Mariposa County. The Stanislaus River and Tulloch Reservoir are generally not visible from this route because of intervening landscape and topography (e.g., elevation changes associated with hills and trees). The surface water elevation in the reservoirs is influenced by seasonal changes and the seasonal operation of the dams and this seasonal variation creates an area of exposed sediment with no vegetation growing (also known as the fluctuation zone).The eligible portion of State Route 108 begins at the junction of State Route 49, east of New Melones and New Don Pedro Reservoirs in the extended plan area, and travels past Sonora to the northern Tuolumne County line (Caltrans 2011). Visibility of the south fork of the Stanislaus River is generally limited due to distance and intervening topography; however, views of other reservoirs in the extended plan area (e.g., Donnell Lake) are afforded to drivers.

The extended plan area primarily includes major portions of the Stanislaus National Forest and all of Yosemite National Park (USFS 2016a). A small portion of the Sierra National Forest is located in the south portion of the extended plan area along the South Fork Merced River in Mariposa and Madera Counties. The extended plan area is bordered by the Humboldt-Toiyabe National Forest and the Inyo National Forest to the west and south. The Stanislaus and Tuolumne Rivers in the Stanislaus National Forest and the Tuolumne and Merced Rivers in Yosemite National Park are used for recreational purposes by a wide variety of different recreationists, including hikers, kayakers, campers, and anglers (USFS 2016b). In-river recreation is typically influenced by the operation of the upstream reservoirs on the Stanislaus and Tuolumne Rivers, similar to the plan area below the three rim dams. For example, the Tuolumne River is well known for some of the most noted whitewater in the high Sierras and is an extremely popular rafting stream below the national park boundary of Yosemite. It is one of the most challenging river runs in California. All private floaters, kayakers, and rafters must obtain permits between May 1 and October 15. Typically, the best floating occurs May through September. However, river flows can be particularly high in the spring, and between the end of the high spring runoff and the beginning of September, the flows on the river are heavily determined by the releases from the Hetch Hetchy Reservoir. Generally flows are high for boaters in the early morning and remain high, and then are reduced to minimum flows in the afternoon. In addition to the in-water activities on the upper Tuolumne River, there are many campsites available to private citizens on a first-come, first-serve basis. (National Wild and Scenic River Systems 2016.)

The reservoirs in the extended plan area are typically smaller than those in the plan area. They generally have less urban and suburban infrastructure around them and offer relatively intact views of the natural landscape including the water vegetation interface along the edge of the reservoirs. The reservoirs offer numerous recreational opportunities. There are numerous recreational opportunities in the extended plan area as it primarily consists of national forests and parks. Recreation at the Stanislaus and Tuolumne River reservoirs in the extended plan area include non-motorized boating, fishing, swimming and camping (USFS n.d.). The Stanislaus National Forest plan has a range of standards and guidelines addressing rural, semi-primitive motorized and primitive recreation (Stanislaus National Forest 2010).

10.2.4 Southern Delta

The majority of the land within the Delta is privately owned, which reduces the availability of land-based recreation (Delta Protection Commission 2010). Navigable waterways in the Delta, however, are publicly accessible and currently constitute the majority of available recreational opportunities (Delta Protection Commission 2010). The southern Delta, specifically, encompasses miles of navigable channels along the San Joaquin, Middle, and Old Rivers. The Clifton Court Forebay, the SWP primary collection reservoir is located northwest of the southern Delta (The Dangermond Group and LSA Associates 2006).

Both privately owned and publicly operated marinas exist throughout the area, including Durham Ferry SRA, Mossdale Marina, Dos Reis Park, Haven Acres Marina, and Tracy Oasis Marina. In addition to boating amenities, these locations provide opportunities for various shore activities, such as fishing and hiking.

A recreation survey conducted by the Department of Recreation in 1996 found that waterskiing, boat cruising, fishing, and swimming were the most popular water-dependent activities in the southern Delta. Of water-enhanced activities, sightseeing was the most common, followed closely by fishing from shore and viewing wildlife (Delta Protection Commission 1997). Sport fishing in the Delta occurs year-round and may take place on private vessels or from shore. Popular sport fish include striped bass, white sturgeon, salmon, American shad, catfish, and largemouth bass (USBR 1999).

The 1996 survey found that recreational use of the southern Delta is proportionally less than the recreational use in other regions of the Sacramento–San Joaquin Delta. The southern Delta is currently estimated to support only 11 percent of the total boating use in the Delta. There are fewer boating and water-associated facilities in the southern Delta compared to the adjoining portions of the Delta to the north. In 2000, an estimated 6.4 million visitor days were associated with boating throughout the Delta (Division of Boating and Waterways 2003).

The water flows in the southern Delta are heavily managed because Central Valley Project (CVP) and SWP pumps are located along the western boundary of the southern Delta. The volume of water in the navigable waterways and the relative quantity of navigable waterways influence available recreational opportunities in the southern Delta. Many of the channels are currently impassable due to snags and vegetation encroachment (Delta Protection Commission 1997). Additionally, during heavy flows, sediment and debris can accumulate, affecting the navigability of the channels and the viability of marinas. Salinity conditions in the southern Delta do not influence the water-dependent or water-enhanced recreational opportunities.

10.3 Regulatory Background

10.3.1 Federal

Relevant federal laws, programs, policies, or regulations related to recreation and/or aesthetics are described below.

Federal Power Act

The Federal Power Act requires the Federal Energy Regulatory Commission (FERC) to give equal consideration to the protection of recreational opportunities and other values when licensing hydropower facilities within its jurisdiction. New Don Pedro and New Exchequer Dams are under FERC's jurisdiction.

Clean Water Act

Section 401 of the federal Clean Water Act requires any applicant for a federal license or permit to conduct any activity, which may result in any discharge to navigable waters, to obtain water quality certification from the State Water Board that the discharge will comply with specified provisions of the Clean Water Act. In issuing water quality certification, the State Water Board certifies that the project will comply with specified provisions of the Clean Water Act, including water quality standards developed pursuant to state law. Water quality standards include beneficial uses, such as recreation. Conditions of certification become conditions of any federal license or permit for the project.

Sierra Resource Management Plan of 2008

Consistent with the Federal Land Policy and Management Act, BLM prepared the Sierra Resource Management Plan to set goals and objectives for various resources, including recreation and aesthetics, on land BLM owns and operates. BLM owns and operates New Exchequer Dam and Lake McClure on the Merced River, New Don Pedro Dam on the Tuolumne River, and portions of land surrounding the reservoirs. This management plan identifies the Lake McClure/Highway 49 and New Melones Reservoir/Stanislaus River viewsheds as Class II visual resources and the Don Pedro Reservoir/Highway 49 viewshed as a Class III visual resource. The plan's objectives include maintaining the existing visual quality of these resources and providing for continued availability of outdoor recreational opportunities while protecting other resources and uses. Specifically, Class II views have an objective to retain the existing character of the landscape and to keep levels of change to the characteristic landscape low. Class III views have an objective to partially retain existing characteristics and moderate changes to the characteristic landscape are acceptable (BLM 2008).

Water and Land Recreation Opportunity Spectrum User's Handbook of 2011

USBR prepared a handbook establishing the Water and Land Recreation Opportunity Spectrum as a tool to understand the type and location of six types of water-related recreation opportunities, which include urban, suburban, rural developed, rural natural, semi-primitive, and primitive recreation opportunities. A particular "package" of activities, setting attributes, experiences, and benefits defines each type. New Melones Reservoir, operated by USBR, has three types: rural developed, rural natural, and semiprimitive. The visual quality objectives of these three types include modification, partial retention, and retention, respectively (USBR 2011a).[5]

New Melones Lake Area Resource Management Plan

The Resource Management Plan (RMP) provides a range of alternatives for managing USBR-administered lands within the New Melones Lake Area. The RMP addresses the interrelationships among the various resources at the New Melones Lake Area and provides options to balance resource management with public use and USBR's mission and authority.

U.S. Forest Service Scenery Management Handbook

Scenery management in the Stanislaus National Forest, which covers much of the extended plan area, is addressed by the *Forest Service Scenery Management Handbook* (USFS 1995). The objective of managing all lands to attain the highest possible visual quality commensurate with other appropriate public uses, costs, and benefits (USFS 2004).

National Wild and Scenic Rivers Act

The Wild and Scenic Rivers Act of 1968 established the National Wild and Scenic River System to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing conditions for the enjoyment of present and future generations. Approximately 2,000 river miles in California have been designated as wild and scenic. This is approximately 1 percent of the state's river miles. Rivers are classified as wild, scenic, or recreational depending on the characteristics of the river (National Wild and Scenic Rivers System 2016).

The definitions of wild, scenic, and recreational as defined by the act are as follows.

- Wild: Those rivers, or sections of rivers, free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.
- Scenic: Those rivers, or sections of rivers, free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

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[5] New Don Pedro Dam and New Exchequer Dam are not operated by USBR.

- Recreational: Those rivers, or sections of rivers, readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

10.3.2 State

Relevant state programs, policies, or regulations related to recreation and/or aesthetics are described below.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act is California's comprehensive water quality control law and is a complete regulatory program designed to protect water quality and beneficial uses of the state's water. It requires by adoption of water quality control plans by the state's nine regional water quality control boards for watersheds within their regions. The State Water Board may also adopt water quality control plans.

San Francisco Bay/Sacramento–San Joaquin Delta Estuary Water Quality Control Plan

The State Water Board's 2006 Bay-Delta Plan identifies beneficial uses of water in the Bay-Delta to be reasonably protected, water quality objectives for the reasonable protection of beneficial uses. Recreation is one of the designated beneficial uses of surface water bodies, including the LSJR and its three eastside tributaries.

California State Scenic Highway Program

California's Scenic Highway Program was created by the legislature in 1963. Its purpose is to protect and enhance the natural scenic beauty of California highways and adjacent corridors through special conservation treatment. A highway may be designated scenic depending on how much of the natural landscape can be seen by travelers, the scenic quality of the landscape, and the extent to which development intrudes upon the traveler's enjoyment of the view (Caltrans 2016).

10.3.3 Regional or Local

Relevant regional or local programs, policies, or regulations related to recreation and/or aesthetics are described below. Although local policies, plans and regulations are not binding to the State of California, below is a description of relevant ones.

Mariposa County General Plan

Chapter 12 of the *County of Mariposa General Plan* includes goals and policies to achieve local recreation service, create programs to provide a range of recreation opportunities and facilities, and cooperate with regional agencies in the development of recreation opportunities. The general plan also contains policies that provide for the establishment of measures for the protection of large-scale views and viewsheds through comprehensive development standards. Standards must take into account the scenic aspect of the county to conserve designated views and viewsheds.

Merced General Plan

The *Recreation and Cultural Resources Element* of the *2030 Merced County General Plan* sets goals and policies to achieve its vision for recreational opportunities. The goals and policies are meant to preserve, enhance, expand, and manage Merced County's system of regional parks, trails, and natural resources.

Tuolumne County General Plan

Chapter 8 of the *Tuolumne County General Plan* includes goals and policies to provide adequate and equitable distribution of recreation facilities, cooperate with other public agencies and private enterprises to provide recreation facilities, acquire and develop land for recreation facilities, and obtain revenue sources to fund recreation. One of the goals of the Tuolumne County General Plan *Conservation and Open Space Element* is to conserve the scenic environment and rural character of the county. The policies for preserving scenic resources address the history of agricultural and timberlands, the natural scenic quality and rural character along designated transportation routes, conserving the natural scenic quality of hillsides and hilltops, and voluntary efforts to protect clusters of native trees and conserve the county's scenic resources.

Stanislaus County General Plan

Chapter 3 of the *Stanislaus County General Plan* emphasizes the conservation and management of natural resources and the preservation of open space for outdoor recreation. It sets goals and policies to maintain the natural environment in areas dedicated as parks and open space and to provide for the open-space recreational needs of the residents of the county.

Calaveras County General Plan

The *Open Space Element* of the *Calaveras County General Plan* states there are significant topographic variations and several resources which contribute to scenic quality. The primary attributes include the lakes, rivers and streams, rolling hills with oak habitat, ridgelines, and forests.

San Joaquin County General Plan

Goals of the *San Joaquin County General Plan* include the preservation of open space for recreation, encouraging the use of waterways for recreation, recognition of scenic routes within the county, providing that water-diversion projects ensure adequate water for recreation, and recognizing that local vegetation communities are important to the recreational experience.

10.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on recreational resources and aesthetics. It further describes the methods of analysis used to determine significance. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

10.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the State Water Board's CEQA regulations. (23 California Code of Regulations [Cal. Code Regs.], §§ 3720–3781.) The thresholds derived from the checklist were modified, as appropriate, to refine the analysis and more accurately describe the impacts of the alternatives. The recreational resource and aesthetic impacts, which were determined as potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*), are discussed in this analysis as to whether the alternatives could result in the following:

- Substantially physically deteriorate existing recreational facilities on the rivers or at the reservoirs.
- Substantially degrade the existing visual character or quality of the reservoirs.
- Have a substantial adverse effect on a scenic vista.
- Substantially damage scenic resources, including trees, rock outcroppings, and historic buildings within a state scenic highway.

Where appropriate specific quantitative or qualitative criteria are described in Section 10.4.2, *Methods and Approach*, for evaluating these thresholds.

As discussed in Appendix B, the new flow requirements would not significantly degrade the visual character or quality of the rivers within the landscape because flows would generally be within the baseline historical range. Viewers would not be sensitive to any changes in flows and associated visual changes. Therefore, potential impacts on the visual character or quality of the riverine landscape are not discussed in this chapter. In addition, as indicated in Appendix B, the LSJR and SDWQ alternatives would have either no impact or less than significant impacts on the following areas related to recreational resources and aesthetics and, therefore, are not discussed within this chapter.

- Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facilities would occur or be accelerated.
- Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment.
- Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area.

10.4.2 Methods and Approach

This chapter evaluates the potential recreation and visual quality impacts associated with the LSJR alternatives using modeling results from the State Water Board's Water Supply Effects (WSE) model for flows and reservoir elevations (Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling*). The modeling results for the LSJR alternatives are compared to the baseline modeled conditions. Recreation surveys were not conducted for the analysis, and existing setting information is based on the most recent available information regarding recreational opportunities at the LSJR, three eastside tributaries, and reservoirs.

The results of the hydrologic modeling are presented below, along with an assessment of the implications of the modeled results for potential impacts on recreation. The analysis identifies the frequency with which flow ranges support different types of flow-dependent recreational activities. Reservoir elevation levels predicted from the hydrologic modeling also are used to determine if the exposed shoreline would modify the aesthetics (i.e., visual character and quality) of the reservoirs experienced by recreationists. The impact analysis then qualitatively discusses if the LSJR alternatives would substantially impact recreation or substantially degrade the visual character and quality of the reservoirs.

This chapter evaluates the potential recreation and aesthetic impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow[6] requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent

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[6] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.

2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature that would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.
4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (for example monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water. For example, terrestrial riparian species could benefit by receiving additional flows during key germination times in the late spring.

The quantitative results included in the figures, tables, and text of this chapter present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). The modeling does allow some inflows to be retained in the reservoirs after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects and this is included in the results presented in this chapter. If the percent of unimpaired flow is not specified in this chapter, these are the percentages of unimpaired flow evaluated in the impact analysis. However, as part of adaptive implementation, method 1 would allow the required percent of unimpaired flow to change by up to 10 percent if the STM Working Group agrees to adjust it. The highest possible percent of unimpaired flow associated with an LSJR alternative is also evaluated in the impact analysis if long-term implementation of method 1 has the potential to affect a determination of significance. For example, if the determination for LSJR Alternative 3 at 40 percent unimpaired flow is less than significant, but the determination for LSJR Alternative 4 at 60 percent unimpaired flow is significant, then LSJR Alternative 3 is also evaluated at 50 percent unimpaired flow. This use of modeling provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

LSJR and Tributary Modeling Methodology and Results

Streamflow affects the recreational water-based opportunities in the rivers below the rim dams. Recreational use of the LSJR and its tributaries occurs year-round, although the most frequent use is during the warmer spring and summer months. Therefore, the effects of the proposed changes in river flows are analyzed for the months of May–September. Unacceptable flows can occur when flows are lower than optimal for boating or swimming or when flows are too high and result in potentially unsafe velocities. Higher flows may also inundate and reduce access to existing on-bank recreation facilities (e.g., campsites).

For in-water recreational opportunities, the flow for different known activities on each of the rivers is compared to the expected modeled flow under each of the alternatives to determine how often the expected modeled flow would fall within the flow ranges. Although optimal flows vary for each river based on hydrologic and geologic conditions, flows can generally be classified into the following optimal flow ranges to evaluate the hydrologic modeling results.

- Less than 500 cfs for swimming, floating, canoeing and kayaking.
- Between 500 and 1,500 cfs for motorized boating, rafting, and kayaking.
- Between 1,500 and 2,500 cfs for advanced rafting or kayaking.

A flow above 2,500 cfs is generally considered unsafe for recreational activities, although advanced whitewater rafting and kayaking often still take place.

The WSE model results are presented as monthly distributions of river flows to provide the basis for the evaluation of potential impacts on recreational opportunities and visual experiences. Average monthly flow conditions that would result from LSJR Alternatives 2, 3, and 4 during the summer recreation season are compared to baseline conditions to determine the magnitude and frequency of the changes in flows that support recreation.

Potential recreation impacts were determined using the WSE model results in a three-step procedure. The first step described recreational opportunities in May–September (i.e., the recreation season) with values for the acceptable range of flows known to support recreation. The second step calculated the frequency of monthly flows that are within this range, based on the monthly WSE model results. In step three, for LSJR Alternatives 2, 3, and 4, the frequency of flows (or reservoir elevations) within this optimal range was then compared to those associated with the baseline. As described in Chapter 5, *Surface Hydrology and Water Quality*, baseline was developed using an 82-year simulation period.

The results of this assessment are presented below, first using the Merced River as an example (Tables 10-2 through 10-4). Summary tables are then presented for the Tuolumne River (Table 10-5) and Stanislaus River (Table 10-6). If the frequency of flows generally supporting a specific recreational activity would decrease more than 10 percent when averaged over the summer recreation season (i.e., the seasonal monthly average frequency of flows within a range that supports a type of recreation would decrease more than 10 percent) a significant impact on a particular type of river recreation may be identified.

The alteration of flow under the LJSR alternatives would not constitute a significant change in visual quality because expected flows are generally within the historical range and views are not as sensitive to these changes. Furthermore, the LSJR alternatives would not influence flood flows currently produced by the rim dams and would reduce the frequency of low flows during critical and critically dry years. Therefore, visual character and quality of the rivers are not discussed further.

Merced River

Common water-dependent recreational activities on the Merced River include swimming, boating, fishing, rafting, and kayaking. Tables 10-2 to 10-4 show the baseline flows suitable for recreation on the Merced River. Table 10-2 gives the full range of monthly flows in the cumulative distribution[7] format, using 10 percent increments from the minimum flow (at the top) to the maximum flow (at the bottom), with the average monthly flow below the maximum value. Table 10-3 shows the percentage of the years that the monthly flows were greater than specified flows of 250–2,500 cfs, in increments of 250 cfs. Tables 10-2 and 10-3 are shown as examples of the type of flow frequency information that is used to generate the summary tables for recreational flow frequencies for each river (i.e., Tables 10-4, 10-5, and 10-6).

Table 10-4 shows the percentage of the years when the Merced River monthly flows were within the four ranges of flows for recreation (e.g., less than 500 cfs, between 500 and 1,500 cfs, etc.) for baseline and the LSJR alternatives. The frequency percentages for the peak recreation season months and the average percentages are shown for all alternatives.

As identified in Table 10-4, the seasonal monthly averages indicate that flows were suitable for swimming in 72 percent of the years, rafting and motorized boating 18 percent of the years, advanced kayaking in 5 percent of the years, and were too high for anything except whitewater boating in 6 percent of the years. The LSJR alternatives would change the Merced River flows primarily in May and June, with less frequent average monthly flows (i.e., less than 500 cfs) and more frequent higher flows. Changes during the months of July–September were smaller. For July and August, the LSJR alternatives had the opposite effect than what they had for May and June; average monthly flows of less than 500 cfs increased, whereas higher flows decreased. The effects of LSJR Alternatives 3 and 4 on river flow during September showed a decrease in the frequency of the lowest flows, as a result of adaptive implementation method 3. For the Merced River, the LSJR

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[7] The cumulative distribution of a particular variable (i.e., reservoir elevations) provides a basic summary of the distribution of values. This term is not referring to, and should not be confused with, the term cumulative impacts, which is a specific CEQA term. A discussion of cumulative impacts for CEQA purposes is provided Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*; Chapter 16, *Evaluation of Other Indirect and Additional Actions;* and Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

alternatives are not expected to have a large effect on the frequency of river flows above 2,500 cfs, except in May under LSJR Alternative 4.

The modeled seasonal average frequency of all flow ranges would generally increase or stay the same under all of the alternatives when compared to baseline, except the frequency of flows less than 500 cfs under LSJR Alternatives 3 and 4, which would decrease to 53 percent and 46 percent, respectively.

Table 10-2. Monthly Cumulative Distributions of Merced River Flow (cubic feet per second [cfs]) at Stevinson for Baseline Conditions (WSE Model Results for 1922–2003)

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
Minimum	280	220	220	220	220	220	0	75	25	25	25	25
10	280	239	239	252	243	220	75	75	25	25	25	25
20	311	252	259	267	261	241	103	100	25	25	25	41
30	330	268	269	275	284	262	189	167	35	43	49	64
40	342	281	278	288	369	278	297	282	76	64	73	84
50	354	291	288	323	526	305	495	439	97	87	90	105
60	365	317	304	374	674	316	541	561	111	113	116	130
70	380	330	335	543	1,118	585	621	668	180	379	813	347
80	416	357	371	1,206	1,925	1,022	745	1,045	1,322	1,241	969	459
90	472	477	1,026	1,676	3,058	1,727	928	2,485	2,986	2,120	1,159	537
Maximum	1,084	2,180	3,495	9,859	5,151	5,959	4,825	5,374	7,279	5,871	2,392	1,263
Average	384	373	496	808	1,132	756	548	797	794	642	422	239

Table 10-3. Percentage of Years with Merced River Flow (cubic feet per second [cfs]) Greater than Specified Flows within the Recreation Range Baseline Conditions (WSE Model Results for 1922–2003)

Flow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
250	98	94	95	96	98	96	78	70	40	30	33	33
500	16	7	13	34	48	32	51	46	24	24	30	16
750	4	5	11	22	38	24	22	29	22	23	27	4
1000	2	2	11	17	29	20	10	18	21	21	18	4
1250	1	2	7	15	26	16	6	16	21	20	7	1
1500	0	2	6	11	24	12	4	15	20	17	2	0
1750	0	1	6	7	20	11	4	12	18	13	1	0
2000	0	0	4	6	15	9	4	12	17	11	1	0
2250	0	0	2	5	11	6	1	11	16	7	1	0
2500	0	0	2	5	11	6	1	11	13	6	0	0

Table 10-4. Percentage of Years with Monthly Merced River Flows within Specified Recreational Ranges (cubic feet per second [cfs]) (WSE Model Results for 1922–2003)

	Months					
Range of Flow	May	June	July	Aug	Sept	Seasonal Average
Baseline						
<500	54	76	76	70	84	72
500–1,500	32	5	7	28	16	18
1,500–2,500	4	6	11	2	0	5
>2,500	11	13	6	0	0	6
LSJR Alternative 2						
<500	24	51	77	72	84	62
500–1,500	61	28	6	26	16	27
1,500–2,500	4	7	11	2	0	5
>2,500	11	13	6	0	0	6
LSJR Alternative 3						
<500	2	29	77	77	78	53
500–1,500	51	50	7	21	22	30
1,500–2,500	35	10	10	2	0	11
>2,500	11	11	6	0	0	6
LSJR Alternative 3 with Adaptive Implementation (50% Unimpaired Flow)						
>2,500	16	12	5	0	0	7
LSJR Alternative 4						
<500	1	17	71	71	71	46
500–1,500	23	38	21	27	29	28
1,500–2,500	40	29	4	2	0	15
>2,500	35	16	5	0	0	11

Notes:
The sum of percentages for each month may not equal 100 due to rounding of values for each flow range.
Gray cells indicate a decrease in the seasonal average greater than 10 percent relative to baseline.
Outlined cells in the table indicate an increase in the seasonal average greater than 10 percent relative to baseline.

Tuolumne River

Common water-dependent recreational activities on the Tuolumne River include boating, fishing, swimming, rafting and kayaking. Table 10-5 shows the percentage of years over the 82-year simulation period in which flows are within specified recreational ranges. The LSJR alternatives are expected to change the Tuolumne River flows in May and June, with flows tending to increase progressively with each LSJR alternative. For example, in June, each of the LSJR alternatives is expected to cause a substantial reduction in the frequency of flows less than 500 cfs. For LSJR Alternative 2, some of the flows would shift from less than 500 cfs under baseline to the 500-1,500 cfs range, whereas for LSJR Alternatives 3 and 4, the flows shift to a range greater than 1,500 cfs. LSJR Alternatives 3 and 4 would cause a large increase in the frequency of flows over 2,500 cfs in May and June. The alternatives generally would cause only small changes in river flows from July–September, except for LSJR Alternative 4, which is expected to cause a moderate decrease in flows greater than 2,500 cfs and an increase in flows from 500–1,500 cfs in July.

The modeled seasonal average flow frequencies show increases in flow under all of the alternatives when compared to baseline. As a result, the frequency of flows less than 500 cfs under LSJR Alternatives 3 and 4 would decrease more than 10 percent to 33 percent and 32 percent, respectively. In addition, the modeled seasonal average frequency of flows of greater than 2,500 cfs would increase more than 10 percent to 23 percent under LSJR Alternative 3 and to 31 percent under LSJR Alternative 4.

Table 10-5. Percentage of Years with Monthly Tuolumne River Flows within Specified Recreational Ranges (cubic feet per second [cfs]) (WSE Model Results for 1922–2003)

	Months					
Range of Flow	May	Jun	Jul	Aug	Sep	Seasonal Average
Baseline						
<500	6	50	51	57	59	45
500–1,500	63	24	30	40	39	40
1,500–2,500	13	6	4	1	2	5
>2,500	17	20	15	1	0	10
LSJR Alternative 2						
<500	1	23	51	57	59	38
500–1,500	52	45	32	40	39	42
1,500–2,500	29	13	2	1	2	10
>2,500	17	18	15	1	0	10
LSJR Alternative 3						
<500	0	9	50	52	52	33
500–1,500	13	23	35	45	45	32
1,500–2,500	29	26	2	1	2	12
>2,500	57	43	12	1	0	23
LSJR Alternative 3 with Adaptive Implementation (50% Unimpaired Flow)						
>2,500	77	56	6	1	0	28
LSJR Alternative 4						
<500	0	5	50	52	52	32
500–1,500	2	18	44	45	45	31
1,500–2,500	13	12	1	2	2	6
>2,500	84	65	5	0	0	31

Notes:
The sum of percentages for each month may not equal 100 due to rounding of values for each flow range.
Gray cells in the table indicate a decrease in the seasonal average greater than 10 percent relative to baseline.
Outlined cells in the table indicate an increase in the seasonal average greater than 10 percent relative to baseline.

Stanislaus River

Common water-dependent recreational activities on the Stanislaus River include boating, fishing, swimming, rafting, and kayaking. Table 10-6 shows the percentage of years when monthly Stanislaus River flows would be within the specific recreational ranges. LSJR Alternative 2 would be expected to have only a small effect on Stanislaus River flows. LSJR Alternatives 3 and 4 would be expected to increase average monthly Stanislaus River flows in May and June, with more frequent average monthly flows over 1,500 cfs in May for LSJR Alternative 3 and more frequent average monthly flows over 2,500 cfs in May and, to a lesser extent, in June (over 1,500 cfs) for LSJR Alternative 4. The alternatives generally would have little effect on river flows July–September, although there would be a moderate increase in flows from 500–1,500 cfs for LSJR Alternative 3. The modeled seasonal average frequency of all flow ranges would generally change little under all of the alternatives when compared to baseline. However, the modeled seasonal average frequency of flows of greater than 2,500 cfs would increase by more than 10 percent to 14 percent under LSJR Alternative 4.

Table 10-6. Percentage of Years with Monthly Stanislaus River Flows within Specified Recreational Ranges (cubic feet per second [cfs]) (WSE Model Results for 1922–2003)

	Months					
Range of Flows	May	June	July	Aug	Sep	Seasonal Average
Baseline						
<500	9%	35%	62%	72%	72%	50%
500–1,500	48%	48%	37%	26%	24%	36%
1,500–2,500	43%	16%	0%	1%	1%	12%
>2,500	1%	1%	1%	1%	2%	1%
LSJR Alternative 2						
<500	5%	30%	59%	71%	70%	47%
500–1,500	55%	57%	40%	24%	24%	40%
1,500–2,500	40%	11%	0%	4%	4%	12%
>2,500	0%	1%	1%	1%	2%	1%
LSJR Alternative 3						
<500	2%	24%	55%	65%	63%	42%
500–1,500	33%	51%	44%	34%	34%	39%
1,500–2,500	51%	20%	0%	0%	1%	14%
>2,500	13%	5%	1%	1%	1%	4%
LSJR Alternative 3 with Adaptive Implementation (50% Unimpaired Flow)						
>2,500 cfs	40%	11%	0%	1%	1%	11%
LSJR Alternative 4						
<500	1%	16%	57%	67%	66%	41%
500–1,500	16%	33%	40%	32%	33%	31%
1,500–2,500	32%	33%	2%	1%	0%	14%
>2,500	51%	18%	0%	0%	1%	14%

The sum of percentages for each month may not equal 100 due to rounding of values for each flow range.
Outlined cells in the table indicate an increase in the seasonal average greater than 10 percent relative to baseline.

Lower San Joaquin River

Available data on the optimal flows on the LSJR do not follow the general trends described above for the eastside tributaries. Sources indicate that boating conditions are optimal at flows less than 750 cfs, while swimming and canoeing are best conducted when flows are less than 300 cfs (USBR 1997; Frago pers. comm.). Opportunities for land-based recreation are limited by flows and access.

Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling*, present modeled flows on the SJR at Vernalis. Because the LSJR flows would be incrementally increased by inflow from the three eastside tributaries, the flows downstream at Vernalis are higher than those upstream (south of the confluence of the Merced River). At Vernalis, the SJR frequently experiences flows that are too high for any in-water recreation other than motorized boating or advanced kayaking and rafting (generally greater than 1,000 cfs in dry years). The hydrologic modeling predicts that LSJR flows would generally continue to be too high to support any in-water recreational opportunities under all alternatives.

LSJR Alternative Reservoir Modeling Methodology and Results

The evaluation of impacts on recreational opportunities at reservoirs is based on the reservoir water surface elevations. When critical low elevations are reached, boat ramps are no longer operational, marinas close, and camping and picnicking opportunities become limited by the small surface area of the reservoir available for recreation. Lower water levels can also reduce the visual character and quality of the reservoir's surroundings. Thus, although reservoirs are subject to a large variation in elevation associated with water releases, weather conditions, and seasonal changes, the quality of the recreation experience is best when the reservoir is full and elevation change is minimal.

Peak recreation seasons vary amongst reservoirs and predominate recreation uses. The majority of use typically occurs during the summer months, between Memorial Day and Labor Day. Thus, this recreation impact analysis focuses on May–September, the period of time when changes in water elevations are most likely to impact recreation.

Visual quality is evaluated qualitatively by identifying the existing visual setting (using the descriptions in Section 10.2.2, *Reservoirs*) of the reservoirs and their assigned visual classifications. It was then determined whether the change in elevation under LSJR Alternatives 2, 3, and 4 would result in a substantial degradation of visual quality. Table 10-7 identifies the visual classifications and the potential for modifying the existing visual setting.

Table 10-7. Summary of Visual Characteristics and Classifications

Reservoir	View Summary	Classification	Potential for Modification
Lake McClure[a]	Lake McClure and Highway 49 viewshed; the Sierra Nevada and aesthetics associated with foothills and mountains	Class II	Retain existing character of the landscape; levels of change to the characteristic landscape should be low
	Developed recreation areas around the reservoir (e.g., Horseshoe Bend) and water infrastructure of dam	Class III	Partially retain existing visual characteristics; the change to the characteristic landscape can be moderate
New Don Pedro[b]	New Don Pedro Reservoir and Highway 49 viewshed; the Sierra Nevada and aesthetics associated with foothills and mountains; developed recreation areas around the reservoir and water infrastructure of the dam	Class III	Partially retain existing visual characteristics; the change to the characteristic landscape can be moderate
New Melones[c]	New Melones Reservoir/Stanislaus River; the Sierra Nevada and aesthetics associated with foothills and mountains	Class II	Retain existing character of the landscape; levels of change to the characteristic landscape should be low
	Residential areas surrounding reservoir; the recreation areas of Tuttletown and Glory Hole; water infrastructure of the dam	Rural Developed	Views can experience modification
	Less developed recreation areas and opportunities; hiking trails	Rural Natural	Views should be partially retained
	Surrounding landscape of the Sierra Nevada	Semi-Primitive	Views should be preserved

Sources:

[a] BLM 2008; Merced ID 2011a; Merced ID 2010.

[b] BLM 2008; TID and MID 2013b.

[c] BLM 2008; USBR 2011a; USBR 2007.

Baseline conditions and LSJR Alternative 2–4 conditions are compared using the lowest one-third of reservoir elevations experienced over the 82-year simulation period for May–September. The lowest one-third is represented by the 30 percent cumulative distribution of reservoir elevations during this time period. This distribution provides a conservative method of evaluating the reservoir elevation data because it represents low elevation conditions typically experienced under drought or dry conditions.

To more fully evaluate the range of potential effects, reservoir recreational conditions are also assessed using the minimum reservoir elevations experienced over the 82-year simulation period for May–September. While the lowest elevations occur infrequently, they result in conditions that can be most detrimental to recreation. Because the alternatives may establish minimum carryover storage requirements, it is possible that the effect of the alternatives on minimum elevation levels may be different than the historical effect observed at the 30 percent cumulative distribution levels over the 82-year simulation period. An increase in the lowest reservoir elevations (i.e., the minimum values out of all 82 years) would represent an improvement in what would be the worst-case conditions for reservoir access. Such an increase may compensate for any effects that might be associated with a decrease in reservoir elevations at the 30 percent cumulative distribution level.

Recreational opportunities and visual character and quality would be potentially restricted during these dry conditions because reduced reservoir elevations affect the usability of recreation facilities and the aesthetics of a reservoir. Recreational opportunities or visual character and quality could be significantly affected if there is a seasonal (May–September) average decrease in reservoir elevation greater than 10 ft, or a decrease below critical elevation levels for certain recreation activities (e.g., elevation levels associated with a boat launch), relative to baseline conditions. Quantifying the conditions in feet provide the actual reservoir elevation under baseline conditions compared to the conditions under the LSJR alternatives. A change of 10 or more feet is expected to result in a visible change to the reservoir elevations noticeable to recreationists. The reservoir elevations are already expected to be low because the evaluation is conducted using reservoir elevations at the 30 percent cumulative distribution level, which represents drier year conditions, as well as the minimum elevations, which represent the driest conditions. These conditions are expected to result in limitations of recreational facilities or visual quality that might not otherwise occur under average baseline conditions. Therefore, this chapter presents a conservative analysis of potential changes when compared to baseline.

Lake McClure

Lake McClure boat ramps cease operation at reservoir levels of 590–793 ft MSL. The ramp at Bagby is the first to close when the reservoir decreases to an elevation of 793 ft MSL, followed by Horseshoe Bend at 758 ft MSL, McClure Point at 650 ft MSL, southern Barrett Cove ramp at 630 ft MSL, and northern Barrett Cove and Piney Creek, both at 590 ft MSL (USBR 1999).

Table 10-8 presents the modeled reservoir elevations of Lake McClure for the LSJR alternatives during May–September. Modeled reservoir elevations under baseline conditions during May–September result in a seasonal change of approximately 81 ft for the 30 percent cumulative distribution and can support the use of most boat ramps. Similarly, the baseline minimum elevations would decrease by 55 ft over the May–September season and could support the use of some boat ramps, although fewer than at the 30 percent cumulative distribution level elevations (Table 10-8).

With the LSJR alternatives, elevations would stay well above 590 ft (the level at which all boat ramps are inoperable). Under LSJR Alternatives 3 and 4, seasonal average reservoir elevations would be greater than baseline by 11 and 9 ft, respectively, at the 30 percent cumulative distribution, and would be 23 ft relative to baseline elevations under LSJR Alternative 2. Seasonal average minimum elevations would be substantially higher than baseline by more than 80 ft under LSJR Alternatives 2 and 3, and by more than 40 ft under LSJR Alternative 4 (Table 10-9).

Table 10-8. Lake McClure May–September Minimum Elevations and Elevations at 30 Percent Cumulative Distribution (feet)

Month	Baseline Conditions	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Elevations at 30 Percent Cumulative Distribution				
May	782	794	776	760
June	775	789	777	766
July	748	769	759	759
August	720	751	741	745
September	701	741	730	742
Minimum Elevations (0 Percent Cumulative Distribution)				
May	546	680	667	660
June	587	686	671	649
July	612	685	683	638
August	615	682	681	618
September	601	673	673	599

Table 10-9. Changes in Lake McClure Minimum Elevations and Elevations at 30 Percent Cumulative Distribution Compared to Baseline (feet)

Month	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Change in Elevations at 30 Percent Cumulative Distribution			
May	12	-6	-21
June	14	2	-9
July	20	11	10
August	31	20	25
September	40	29	41
Seasonal Average	23	11	9
Minimum Elevations (0 Percent Cumulative Distribution)			
May	134	121	114
June	99	84	62
July	72	71	25
August	68	66	3
September	72	72	-2
Seasonal Average	89	83	41

New Don Pedro Reservoir

The maximum reservoir level for recreational use of New Don Pedro Reservoir is 830 ft MSL. Reservoir levels below 790 ft MSL generally result in lower recreational use (USBR 1999). At 780 ft MSL, beach use declines. Below 720 ft MSL some boat ramps become inoperable, reservoir surface area is limited, and campground and picnicking use declines (USBR 1999). At 630 ft MSL, the marina at Moccasin Point closes, and at 600 ft MSL, the boat launch and marina at Flemming Meadows become inoperable (USBR 1999).

Table 10-10 presents the modeled reservoir elevations at New Don Pedro Reservoir for the LSJR alternatives May–September for minimum elevations and at the 30 percent cumulative distribution. New Don Pedro Reservoir baseline elevations are below 780 ft MSL July–September at the 30 percent cumulative distribution and the minimum elevations are well below 780 ft for May–September. Reservoir elevations do not decrease to 630 ft under baseline (i.e., two marinas remain operational). Under baseline conditions, the seasonal May–September change in reservoir elevation is 51 ft for the 30 percent cumulative distribution and 42 ft for minimum elevations.

As presented in Table 10-11, implementation of LSJR Alternatives 3 and 4 would result in a decrease in the seasonal average reservoir elevations of more than 15 ft at the 30 percent cumulative distribution. Under LSJR Alternative 2, there would be a 3-foot decrease in the seasonal average reservoir elevation at the 30 percent cumulative distribution. However, reservoir elevation at the 30 percent cumulative distribution would not decrease below 720 ft (the level at which some boat ramps become inoperable and campgrounds and picnicking use begin to decline) for any of the alternatives. The seasonal average minimum elevation under LSJR Alternative 2 would be more than 15 ft higher than baseline. Under LSJR Alternatives 3 and 4, seasonal average minimum elevations would be 10 or more feet higher relative to baseline.

Table 10-10. New Don Pedro Reservoir May–September Minimum Elevations and Elevations at 30 Percent Cumulative Distribution (feet)

Month	Baseline Conditions	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Elevations at 30 Percent Cumulative Distribution				
May	795	792	767	759
June	787	783	760	753
July	770	765	749	747
August	753	749	741	739
September	744	742	734	736
Minimum Elevations (0 Percent Cumulative Distribution)				
May	700	711	702	706
June	683	701	692	693
July	674	688	679	686
August	663	679	679	681
September	658	676	677	680

Table 10-11. Changes in New Don Pedro Reservoir Minimum Elevations and Elevations at 30 Percent Cumulative Distribution Compared to Baseline (feet)

Month	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Change in Elevations at 30 Percent Cumulative Distribution			
May	-3	-28	-36
June	-3	-26	-33
July	-5	-21	-22
August	-4	-12	-14
September	-2	-10	-8
Seasonal Average	-3	-19	-23
Minimum Elevations (0 Percent Cumulative Distribution)			
May	11	3	6
June	18	9	10
July	14	5	12
August	16	16	18
September	18	19	23
Seasonal Average	16	10	14

New Melones Reservoir

On New Melones Reservoir, the optimal reservoir water level for recreation is 950–980 ft MSL (State Water Board 1999). Below 900 ft MSL, use of beaches declines. Below 880 ft MSL, the marina closes. At 860 ft MSL, the last official boat ramp (Glory Hole) becomes inoperable, reservoir surface area is limited, and campground and picnicking use declines. Below 850 ft MSL, all boat launches are inoperable (USBR 1999).

Table 10-12 shows modeled New Melones Reservoir elevations for the LSJR alternatives from May–September. New Melones Reservoir has experienced elevations below 950 ft (the lowest level for optimal recreation), resulting in baseline reductions to recreational opportunities. Under baseline conditions, the seasonal May–September change in reservoir elevation is 32 ft for the 30 percent cumulative distribution and 35 ft for the minimum elevations.

Hydrologic modeling of the LSJR alternatives predicts higher reservoir elevations than the predicted baseline seasonal elevations for the May–September period. Under baseline conditions, minimum reservoir elevations were below 850 ft MSL, the level at which boat launches become inoperable. In contrast, under all of the alternatives, minimum elevations would be above 850 ft.

As presented in Table 10-13, under LSJR Alternative 2, the seasonal average reservoir elevation would be 26 ft higher than baseline at the 30 percent cumulative distribution level. Seasonal average reservoir elevations for LSJR Alternatives 3 and 4 would increase 14 ft and 8 ft above baseline, respectively. Seasonal average minimum elevations would be higher than baseline by more than 120 ft under all LSJR alternatives.

Table 10-12. New Melones Reservoir May–September Minimum Elevations and Elevations at 30 Percent Cumulative Distribution (feet)

Month	Baseline Conditions	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Elevations at 30 Percent Cumulative Distribution				
May	944	966	953	938
June	941	967	952	942
July	929	957	944	937
August	917	945	934	934
September	913	938	930	932
Minimum Elevations (0 Percent Cumulative Distribution)				
May	770	883	890	880
June	758	880	887	877
July	747	877	884	873
August	738	874	881	870
September	735	874	881	870

Table 10-13. Changes in New Melones Reservoir Minimum Elevations and Elevations at 30 Percent Cumulative Distribution Compared to Baseline (feet)

Month	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Change in Elevations at 30 Percent Cumulative Distribution			
May	22	8	-6
June	27	11	2
July	27	15	8
August	27	17	17
September	25	17	19
Seasonal Average	26	14	8
Minimum Elevations (0 Percent Cumulative Distribution)			
May	113	120	110
June	123	129	119
July	130	137	126
August	136	143	132
September	139	146	135
Seasonal Average	128	135	124

Tulloch Reservoir

Water surface levels in Tulloch Reservoir are maintained through coordinated water releases from the New Melones Dam upstream and the Tulloch Dam downstream. Although the LSJR alternatives could alter the quantity of water flowing into Tulloch Reservoir, equivalent quantities of water would be released through Tulloch Dam. Therefore, while there would be different monthly flows through Tulloch Reservoir in LSJR Alternatives 2, 3, and 4, the surface elevations of the reservoir would not change.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, salinity levels in the southern Delta are expected to remain within their historical range (i.e., 0.2–1.2 deciSiemens per meter). Salinity levels in the southern Delta have a strong relationship with the salinity measured at Vernalis, and the SDWQ alternatives would not change historical water quality Vernalis. As part of these alternatives, reservoirs would continue to operate to meet the existing Vernalis EC[8] objective through the SDWQ program of implementation, thereby maintaining flows and water quality at Vernalis. As discussed in Appendix B, *State Water Board's Environmental Checklist*, changes in salinity do not result in changes to water-dependent or water-enhanced recreational opportunities in the southern Delta. Salinity fluctuations within the historical range are imperceptible to recreationists that use the southern Delta for water-dependent activities, such as boating or kayaking, and water-enhanced activities, such as wildlife viewing. As discussed in Chapter 7, *Aquatic Biological Resources*, salinity fluctuations within the historical range would not affect fish that inhabit the LSJR and southern Delta channels. Since salinity fluctuations fall within the historical range of salinity in the southern Delta, recreational fishing in the southern Delta would not be affected. Therefore, the SDWQ alternatives are not discussed further in this chapter with respect to recreational resources. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on recreational resources or aesthetics. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

As discussed in Appendix B, changes in salinity would not result in substantial changes to visual character or quality or aesthetics. The SDWQ alternatives are not applicable to the reservoirs and eastside tributaries. SDWQ alternatives are not discussed further in this chapter with respect to

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[8] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

aesthetics. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on recreational resources or aesthetics. These impacts are evaluated in Chapter 16.

10.4.3 Impacts and Mitigation Measures

Impact REC-1: Substantially physically deteriorate existing recreational facilities on the rivers or at the reservoirs

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

The LSJR alternatives may substantially physically deteriorate the condition of existing recreation facilities at reservoirs or on rivers. The condition of an existing recreational facility or feature is considered impaired if it is physically damaged or deteriorated in such a way that recreationists are unable to use it.

At recreational areas along the Stanislaus, Tuolumne, and Merced Rivers and the LSJR, an increase in the magnitude and frequency of high-flow conditions, such as conditions above 2,500 cfs or flood control releases, could damage existing on-bank recreation facilities (e.g., canoe/kayak put-ins, picnic areas, campgrounds, restrooms, and parking areas). Many recreational activities are limited to range of flows. A substantial increases in flows during the summer months could result in certain recreationists being unable to use the river for certain types of in-water activities.

Reductions in reservoir water elevations, as expected under the LSJR alternatives, could increase the distance between established facilities and the water, or reducing available reservoir area. Reservoir recreational use is known to decrease as receding water levels reduce water surface area, make boat ramps less accessible, and leave recreation facilities farther from shorelines (DWR 1994; USBR 1999).

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Rivers

Under LSJR Alternative 2, the frequency and magnitude of higher flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would be similar to baseline, exhibiting little fluctuation in July, August, and September. Modeled frequencies of flows greater than 2,500 cfs under LSJR Alternative 2 would generally decrease or stay the same on the three eastside tributaries (Tables 10-4, 10-5, and 10-6). These flows are not expected to result in more frequent inundation of on-bank recreation facilities during the recreation season. Therefore, existing facilities are not expected be substantially deteriorated as a result of implementing LSJR Alternative 2.

The Tuolumne River and Merced River would generally experience fewer low flows (i.e., flows less than 500 cfs) in May and June and more mid-range flows (i.e., 500–1,500 cfs) optimal for boating and fishing during this time (Tables 10-4 and 10-5), although there would be an 11 percent decrease in flows between 500 and 1500 cfs relative to baseline in May on the Tuolumne River. On the Stanislaus River between May and June, there would be little change in flow compared to baseline conditions, with the exception of a 10 percent increase in mid-range flows in June (Table 10-6). The seasonal average frequency of flows within the ranges that support recreation would not decrease substantially (i.e., more than 10 percent) relative to baseline on any of the three eastside tributaries (Tables 10-4, 10-5 and 10-6). Therefore, in-water recreational conditions on these rivers are not expected to be substantially reduced under LSJR Alternative 2. The flows on the downstream end of the SJR at Vernalis are expected to increase in May and June, but generally remain the same July–September. These flows are generally too high for swimming or wading, but motorized boating or advanced kayaking or rafting could continue.

The historic hydrology of the three eastside rivers and the LSJR influences the types and conditions of recreational facilities and features, as well as the designated beneficial recreational uses, in and around these rivers. A change in the magnitude or duration of flows in rivers may somewhat alter the in-water recreational uses of the rivers under LSJR Alternative 2, as described above. While increased flows may lead to slightly fewer opportunities for swimming, these flows would likely lead to improved conditions for kayaking and whitewater rafting. Increased flows may also lead to more opportunities for on-bank recreational activities, such as wildlife viewing. In addition, increased flows are expected to improve conditions for fish (see Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30*, for details regarding expected fish benefits). While it is unknown whether any increase in fish populations would be large enough to specifically and measurably enhance sport fishing opportunities on the rivers, some beneficial effects related to recreational fishing are anticipated. Accordingly, the rivers would continue to support the designated beneficial uses of recreation, as described in the Basin Plan (State Water Board 1998), and would not conflict with the support and continuation of recreational facilities and features as identified in local plans and policies.

Implementation of LSJR Alternative 2 would not substantially physically deteriorate existing recreation facilities on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Therefore, use of these facilities would not decrease and impacts on recreational resources at these rivers would be less than significant.

Reservoirs

At Lake McClure, the simulated seasonal average elevation (May–September) under LSJR Alternative 2 would increase by 23 ft at the 30 percent cumulative distribution, and the seasonal average of the minimum elevations would increase substantially (89 ft [Tables 10-8 and 10-9]). At New Don Pedro Reservoir, there would be a small decrease (3 ft) in the seasonal average elevation at the 30 percent cumulative distribution and an increase of 16 ft for the minimum elevations (Tables 10-10 and 10-11). At New Melones Reservoir, substantial increases in elevation are expected for both the minimum elevations and elevations at the 30 percent cumulative distribution under LSJR Alternative 2 (Tables 10-12 and 10-13). These modeled reservoir elevations under LSJR Alternative 2 would generally maintain recreational facilities at the reservoirs (e.g., boat launches) and it is expected that changes in reservoir elevations would not substantially affect the condition of existing recreation facilities. Accordingly, it is anticipated this alternative would not conflict with existing plans and policies supporting recreation and recreational facilities at the reservoirs. Therefore, impacts on recreational resources would be less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. For example, an increase to 30 percent of unimpaired flow would result in a greater opportunities for in-water recreation at higher river flows, than at 20-percent unimpaired flow.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June time frame. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent.

Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. The WSE model results show that under LSJR Alternative 2 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 2.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required 0.7 percent of the time to meet a 1,000-cfs requirement and 0.5 percent of the time for an 800-cfs Vernalis base flow requirement. These results indicate that changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR.

Impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3. With method 1, if the specified percent of unimpaired flow were changed from 20 percent to 30 percent on a long-term basis, the conditions and impacts could become more similar to those described under LSJR Alternative 3 (e.g., 30 percent unimpaired flow). It is anticipated that over time the unimpaired flow requirement could increase or not change at all within a year or between years, depending on fish and wildlife conditions and hydrology. If method 2 is implemented, the total annual volume of water associated with LJSR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change. It is unlikely that alteration of the timing of the river flows would result in substantial modification to the May through September flows or that alteration of the timing of the flows would produce large changes in monthly reservoir storage values. Ultimately, the reservoirs would release the same total amount of water. On average, there would be little change in reservoir elevations. Further, given that this method would not allow flows to go below what is required by existing requirements on the three tributaries and the SJR, impacts would be similar to those described above for LSJR Alternative 2 without adaptive implementation. Implementing method 4 is expected to have little effect on conditions in the three eastside tributary rivers and LSJR because it rarely would cause a change in flow and the volume of water involved would be relatively small. Consequently, the impact determination for LSJR Alternative 2 with adaptive implementation would be the same as described above for LSJR Alternative 2 without adaptive implementation. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Significant and unavoidable with adaptive implementation)

Rivers

Under LSJR Alternative 3, modeled frequencies of flows greater than 2,500 cfs would generally change little on the Merced and Stanislaus Rivers (Table 10-4 and 10-6). Thus, on-bank recreation facilities would not experience substantially more inundation compared to baseline conditions. Flows greater than 2,500 cfs would increase in frequency on the Tuolumne River in May and June, but would remain about the same relative to baseline July–September (Table 10-5). Although the flows on the Tuolumne River would likely result in an increase in the frequency of inundation of on-bank recreation areas during a few months in the recreation season, this inundation is not anticipated to substantially physically deteriorate the recreation facilities along the river. Recreation facilities are constructed in close proximity to rivers and are capable of withstanding periodic inundation by higher flows. Furthermore, higher flow events would not impact recreation areas at higher elevations. For example, the 250 acre Caswell Memorial Park contains some campsites that inundate at flows greater than 5,000 cfs. However, other campsites in the park remain available at high flows. Moreover, the existing capacity of similar facilities in the region would allow use to shift to facilities at higher elevations during these periods of high flow.

Lower flows would be less frequent on the three eastside tributaries in May and June under LSJR Alternative 3. On the Merced River, this would correspond to an increase in the frequency of 500-2,500 cfs flows, while on the Tuolumne and Stanislaus Rivers, flows greater than 1,500 cfs (including flows greater than 2,500 cfs) would be more common than under current and past conditions (Tables 10-4, 10-5 and 10-6). The modeled seasonal monthly average frequency of low flow conditions known to support swimming and wading would decrease nearly 20 percent on the Merced River and more than 10 percent on the Tuolumne River (Tables 10-4 and 10-5, respectively). However, on these two rivers, the frequency of low flows (less than 500 cfs) in July-September would experience little net change compared to baseline conditions (Tables 10-4 and 10-5). Therefore, during the warmest months in the San Joaquin Valley, when swimming and wading are typically the most popular, there would be little change relative to baseline conditions. As such, overall, the reduced condition for swimming and wading on the Merced and Tuolumne Rivers during May and June (i.e., early in the summer recreational season) is not expected to substantially reduce in-water recreation for the season.

The flows on the SJR at Vernalis are expected to increase in May and June, but generally remain the same July–September. These flows would generally remain too high for swimming or wading, but motorized boating or advanced kayaking or rafting may continue. Conditions for water-dependent recreation would be expected to be similar to past and present conditions.

The historic hydrology of the three eastside rivers and the LSJR influence the types and conditions of recreational facilities and features, as well as the designated beneficial recreational uses, in and around these rivers. A change in the magnitude or duration of flows in rivers may somewhat alter the in-water recreational uses of the rivers under LSJR Alternative 3, as described earlier. While increased flows may lead to slightly fewer opportunities for swimming, they would likely lead to improved conditions for kayaking and whitewater rafting. They may also lead to more opportunities for on-bank recreational activities such as wildlife viewing. In addition, increased flows are expected to improve conditions for fish (see Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30,* for details regarding expected fish benefits). While it is unknown whether any increase in fish populations would be large enough to specifically and measurably enhance sport fishing opportunities within the rivers, some beneficial effects related to recreational fishing are anticipated. Accordingly, the rivers would continue to support the designated beneficial uses of recreation, as described in the Basin Plan, and would not conflict with the support and continuation of recreational facilities and features as identified local plans and policies.

Implementation of LSJR Alternative 3 would not substantially physically deteriorate existing recreation facilities on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Therefore, use of these facilities would not be reduced, and impacts on recreational resources at these rivers would be less than significant.

Reservoirs

LSJR Alternative 3 would not significantly affect reservoir elevations at Lake McClure. Relative to baseline, seasonal average elevation would increase 11 ft at the 30 percent cumulative distribution, while seasonal average minimum elevation would increase 83 ft (Tables 10-8 and 10-9). Under LSJR Alternative 3, greater increases of both the minimum elevation (135 ft) and the elevation at the 30 percent cumulative distribution (14 ft) are expected at New Melones Reservoir (Tables 10-12 and 10-13). Accordingly, it is anticipated that this alternative would not conflict with existing plans and policies supporting recreation and recreational facilities at the reservoirs. Therefore, implementation of LSJR Alternative 3 would not substantially physically deteriorate, and thereby reduce the use of, existing recreation facilities at Lake McClure and New Melones Reservoir.

At New Don Pedro Reservoir, a substantial decrease in elevation is expected at the 30 percent cumulative distribution (seasonal average decrease of 19 ft). A 10-foot increase in seasonal average minimum elevations will dampen but not completely compensate for this decrease in seasonal average elevation (Tables 10-10 and 10-11). Reservoir elevation at the 30 percent cumulative distribution would not decrease below 720 ft (the level at which some boat ramps become inoperable and campgrounds and picnicking use begin to decline).Therefore all boat ramps are expected to remain operable under LSJR Alternative 3 at the 30 percent cumulative distribution elevation, with some boat ramps operable at minimum reservoir elevations. While lower elevations may somewhat impinge upon recreationists’ access to boat ramps, the shoreline, or other recreational facilities, these change would not substantially physically deteriorate existing recreation facilities. Accordingly, it is anticipated this alternative would not conflict with existing plans and policies supporting recreation and recreational facilities at this reservoir. Implementation of LSJR Alternative 3 would not substantially physically deteriorate, and thereby reduce the use of, existing recreation facilities at New Don Pedro Reservoir.

Implementation of LSJR Alternative 3 would not substantially physically deteriorate or reduce the use of existing recreation facilities at Lake McClure, and New Melones and New Don Pedro Reservoirs. Accordingly, it is anticipated this alternative would not conflict with existing plans and policies supporting recreation and recreational facilities at these reservoirs. Therefore, this impact would be less than significant.

Adaptive Implementation

Under LSJR Alternative 3, impacts associated with adaptive implementation method 1 may be slightly different from those associated with adaptive implementation methods 2 and 3. Implementing method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40-percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time.

Adaptive implementation method 1 could affect the amount of water available for water supply and the volume of water and level of flow in the LSJR and its tributaries. However, an increase of up to 50 percent of unimpaired flow would potentially result in different effects as compared to the 40 percent unimpaired flow, depending upon flow conditions and the frequency of the adjustment. If the adjustment occurs frequently or for extended durations, impacts under LSJR Alternative 3 could become more like the impacts under LSJR Alternative 4. Model results indicate that if flow were increased from 40 percent of unimpaired flow to 50 percent of unimpaired flow, there would be substantial increases in the percent of time that May and June flows on the Tuolumne River would exceed 2,500 cfs (Tables 10-5 and 10-6). Accordingly, LSJR Alternative 3, with adaptive implementation method 1, would cause substantial deterioration of existing recreational facilities.

Under adaptive implementation methods 2 or 3, the overall volume of water from the February–June time period or after June would be the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. It is unlikely that alteration of the timing of the river flows would result in substantial modification to the May through September flows or that alteration of the timing of the flows would produce large changes in monthly reservoir storage values. Ultimately, the same total amount of water would be released, so on average, there would be little change in reservoir elevations. Further, given that these two methods would not allow flows to go below what is required by existing requirements on the three tributaries and the SJR, impacts would be similar to those described above for LSJR Alternative 3 without adaptive implementation. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June minimum flow requirement. The WSE model results indicate changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR, and thus would not affect recreation. Accordingly, LSJR Alternative 3, with adaptive implementation methods 2, 3, and 4, would not substantially affect recreational resources.

The historic hydrology of the three eastside rivers and the LSJR influence the types and conditions of recreational facilities and features, as well as the designated beneficial recreational uses, in and around these rivers. A change in the magnitude or duration of flows in rivers may somewhat alter the in-water recreational uses of the rivers under LSJR Alternative 3 with adaptive implementation method 1, as described earlier. Specifically, a shift to higher-flow recreational uses would be expected with more frequent higher flows on the Stanislaus and Tuolumne Rivers. This may result in more opportunities for boating on the LSJR and fewer opportunities for swimming and wading; however, there are ample locations for swimming in the area, including in the Upper SJR and plan area reservoirs. Higher flows may also lead to more opportunities for on-bank recreational activities such as wildlife viewing or bird watching. In addition, increased flows are expected to improve conditions for fish (see Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30,* for details regarding expected fish benefits). While it is unknown whether any increase in fish populations would be large enough to specifically and measurably enhance sport fishing opportunities within the rivers, some beneficial effects related to recreational fishing are anticipated. Accordingly, the rivers would continue to support the designated beneficial uses of recreation, as described in the Basin Plan (State Water Board 1998), and would not conflict with the support and continuation of recreational facilities and features as identified in local plans and policies. However, because the frequency of the higher flows is expected to substantially increase under LSJR Alternative 3, with adaptive implementation, it is likely that existing on-bank recreational facilities would be inundated more frequently and substantial physical deterioration would occur, thus reducing the use of the facilities. Therefore, impacts are significant.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Reducing the occurrence of flows greater than 2,500 cfs, particularly in May and June on the Tuolumne River, could reduce this significant impact, but such a reduction would directly contradict the purpose of LSJR Alternative 3, with adaptive implementation, to potentially increase the flow, based on best available scientific information, for the beneficial use of wildlife and fish. This mitigation is, therefore, infeasible. Furthermore, evaluating the effects of lower flows on the different rivers is part of LSJR Alternative 2 and is separately considered in this document. Owners and operators of on-bank recreational facilities should operate and maintain the facilities to minimize physical deterioration from increased inundation, such as increased facility inspections and repairs. The State Water Board, however, lacks authority to require this mitigation measure. As such, LSJR Alternative 3, with the implementation of adaptive implementation method 1, would remain significant and unavoidable.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Rivers

In May and June, modeled frequencies of flows greater than 2,500 cfs under LSJR Alternative 4 would substantially increase on the three eastside tributaries, particularly in the Tuolumne and Stanislaus Rivers (Tables 10-5 and 10-6, respectively). There would be little change in high flows from July–September (Tables 10-5 and 10-6). Although on-bank recreation facilities at all of these rivers are purposefully built adjacent to, and within close proximity of, rivers and are able to withstand periodic inundation by higher flows, the frequency of flows predicted under LSJR Alternative 4 would likely result in much more regular inundation of adjacent on-bank recreational facilities along the Tuolumne River than is currently experienced under baseline. This increase in frequency would likely contribute to substantial physical deterioration over time, thus resulting in a substantial reduction in use of the facilities. This could potentially result in increased use of other nearby facilities by recreationists or a shift to water-enhanced activities (such as hiking). Therefore, impacts would be significant.

Lower flows would be less frequent on the three eastside tributaries in May and June under LSJR Alternative 4. On the Merced River, the modeled seasonal average frequency of flows less than 500 cfs would decrease by 26 percent relative to baseline, and there would be a 13 percent and 9 percent decrease on the Tuolumne River and Stanislaus River, respectively. Thus, the frequency of flows for lower flow recreational uses such as swimming, particularly in May and June, would substantially decrease (Tables 10-4 and 10-5). As a result of the increases in flow, the Merced River may experience increases in all recreational flow categories other than those for swimming and floating, and the Tuolumne River may provide more opportunity for advanced kayaking recreationists. Because there would be little change in high flows on the Merced River July–September, and on the Tuolumne River August and September, the warmest months in the San Joaquin Valley, when swimming and wading are typically the most popular, there would be little change relative to baseline conditions. As such, overall, the reduced opportunity for swimming and wading on the Merced and Tuolumne Rivers during May, and particularly during June (i.e., early in the summer recreational season), is not expected to substantially change in-water recreation conditions for the season. Low-flow water-dependent recreational conditions conducive to swimming in the Stanislaus River would be most affected during June, but the seasonal average frequency of flows supporting various recreation types are not expected to decrease more than 10 percent through the summer recreation season (Table 10-6).

Flows on the LSJR would remain generally too high for in-water recreational activities other than motorized boating and advanced rafting or kayaking at Vernalis in the northern extent of the plan area. While there is little known use of the southern portion of the LSJR for swimming, conditions for water-dependent recreation would be expected to be similar to past and present conditions.

The historic hydrology of the three eastside rivers and the LSJR influence the types and conditions of recreational facilities and features, as well as the designated beneficial recreational uses, in and around these rivers. A change in the magnitude or duration of flows in rivers may somewhat alter the in-water recreational uses of the rivers under LSJR Alternative 4, as described above. Specifically, a shift to higher-flow recreational uses would be expected with more frequent higher flows on the Merced and Tuolumne Rivers in May and June flow into the LSJR. This may result in more opportunities for boating on the LSJR and fewer opportunities for swimming and wading; however, there are ample locations for swimming in the area, including in the Upper SJR and at the plan area reservoirs. Higher flows may also lead to more opportunities for on-bank recreational activities such as wildlife viewing or bird watching. In addition, increased flows are expected to improve conditions for fish (see Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30,* for details regarding expected fish benefits). While it is unknown whether any increase in fish populations would be large enough to specifically and measurably enhance sport fishing opportunities within the rivers, some beneficial effects related to recreational fishing are anticipated. Accordingly, the rivers would continue to support the designated beneficial uses of recreation, as described in the Basin Plan (State Water Board 1998), and would not conflict with the support and continuation of recreational facilities and features as identified local plans and policies.

However, because the frequency of the higher flows is expected to substantially increase under LSJR Alternative 4, it is likely that existing on-bank recreational facilities would be inundated more frequently, and substantial physical deterioration would result, thus reducing the use of the facilities. Therefore, impacts are significant.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) Reducing the occurrence of flows greater than 2,500 cfs, particularly in May and June on the Stanislaus and Tuolumne Rivers could reduce this significant impact, but such a reduction would directly contradict the purpose of LSJR Alternative 4. Furthermore, evaluating the effects of lower flows on the different rivers is part of the other alternatives and is separately considered in this document. Requiring less flow, beyond that prescribed by adaptive implementation method 1 further described below, cannot be independently applied under LSJR Alternative 4 as a mitigation measure because requiring flow reductions would be inconsistent with the terms of LSJR Alternative 4, with or without adaptive implementation, and is, therefore, infeasible. Owners and operators of on-bank recreational facilities should operate and maintain the facilities to minimize physical deterioration from increased inundation, such as increased inspections and repairs. The State Water Board, however, lacks authority to require this mitigation measure. As such, impacts under SJR Alternative 4 would remain significant and unavoidable.

Reservoirs

LSJR Alternative 4 seasonal average reservoir elevations at Lake McClure would increase by 9 ft at the 30 percent cumulative distribution and would increase by 41 ft at minimum (Tables 10-8 and 10-9). At New Melones Reservoir, substantial increases in seasonal average minimum elevations (124 ft) are expected and seasonal average elevations at the 30 percent cumulative distribution (8 ft) would be minimally affected under LSJR Alternative 4 (Tables 10-12 and 10-13). Therefore, implementation of LSJR Alternative 4 would not substantially physically deteriorate nor reduce the use existing recreation facilities at these reservoirs.

At New Don Pedro Reservoir, a substantial decrease in elevation is expected at the 30 percent cumulative distribution (seasonal average decrease of 23 ft), which would be somewhat, but not entirely, compensated for by increases in the minimum elevations (seasonal average increase of 14 ft) (Tables 10-10 and 10-11). It is expected that these changes would not substantially physically deteriorate existing recreation facilities. At the 30 percent cumulative distribution, all boat ramps would remain operational under LSJR Alternative 4 at New Don Pedro Reservoir. Minimum elevations at New Don Pedro Reservoir were below 726 ft for both baseline and LSJR Alternative 4, but were generally higher for LSJR Alternative 4 than for baseline. LSJR Alternative 4 would not render existing recreation facilities inoperable and, therefore, would not results in physical deterioration of the existing facilities.

Implementation of LSJR Alternative 4 would not substantially physically deteriorate the existing recreation facilities at Lake McClure, and New Melones and New Don Pedro Reservoirs. Therefore, use of these facilities would not be reduced, and this impact would be less than significant.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on recreational resources. As discussed under LSJR Alternative 3, adaptive implementation method 3 would result in similar impacts to those described above. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the February–June, 60-percent unimpaired flow requirement (to 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3, with adaptive implementation. The modeling results show that if the adjustment occurs frequently or for extended durations, impacts would be significant and are no different than those presented for LSJR Alternative 4.

Impact REC-2: Substantially degrade the existing visual character or quality of the reservoirs

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Low water levels at reservoirs can expose a less visually pleasing shoreline to recreationists that is devoid of vegetation due to fluctuating water elevations (DWR 1994; USBR 1999). As summarized in Table 10-7 in Section 10.4.2, *Methods and Approach*, views at the Lake McClure and New Don Pedro and New Melones Reservoirs are classified to indicate if modification of the views or visual character and quality of each reservoir are acceptable or if retention of views is recommended. The views of Lake McClure and New Melones Reservoir are classified as Class II, indicating that views and retention of the existing character of the landscape is recommended. The views of Don Pedro Reservoir are classified as Class III, indicating that views and changes to the character of the landscape can be moderate.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

The change in the three reservoir elevations would not result in a substantial change to the existing visual character of the reservoirs. The changes in reservoir elevations at Lake McClure and New Melones Reservoir could result in an improvement to the existing views as reservoir elevations are expected to increase under certain conditions. As described under Impact REC-1, there would be a minimal decrease in reservoir elevations at New Don Pedro Reservoir at the 30 percent cumulative distribution relative to baseline; however, it is not anticipated this 3-foot seasonal average decrease would result in a substantial degradation of the visual character of the reservoir. Adaptive implementation is not anticipated to substantially change this effect. Therefore, viewers would continue to experience the water–land interface and would continue to see water from viewpoints, and this visual experience would not conflict with existing plans or policies meant to support or maintain existing views. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Reservoir elevations are expected to change as described above for Impact REC-1. The changes in elevations at Lake McClure and New Melones Reservoir could result in an improvement to the existing views as reservoir elevations are expected to increase under certain conditions. This visual experience would not conflict with existing plans or policies meant to support or maintain existing views. Adaptive implementation is not anticipated to substantially change these effects. Therefore, impacts would be less than significant.

As described under Impact REC-1, there would be a substantial decrease in reservoir elevations at New Don Pedro Reservoir at the 30 percent cumulative distribution relative to baseline. However, it is not anticipated this decrease would result in a substantial degradation of the visual character of the reservoir. This is because the views of Don Pedro Reservoir are classified as Class III views. These views are considered lower quality under existing conditions and can, therefore, be more readily modified as a result of the Class III designation. Reservoir elevation fluctuations are typical of this environment. Furthermore, viewers would still experience the reservoir, the existing fluctuation of elevation, and lack of vegetation within the fluctuation zone, all within the context of the foothills and mountains. Finally, although the water elevations would change, recreationists would continue to experience the water–land interface. This visual experience would not conflict with existing plans or policies meant to support or maintain existing views. Adaptive implementation is not anticipated to substantially change these effects. Therefore, impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Reservoir elevations are expected to change as described above for Impact REC-1. The changes in elevations at Lake McClure and New Melones Reservoir could result in an improvement to the existing views as a reservoir elevations are expected to increase under certain conditions. This visual experience would not conflict with existing plans or policies meant to support or maintain existing views. Adaptive implementation is not anticipated to substantially change these effects. Therefore, impacts would be less than significant.

As described under Impact REC-1 for LSJR Alternative 4 there would be a substantial decrease in reservoir elevations at New Don Pedro Reservoir at the 30 percent cumulative distribution relative to baseline; however, it is not anticipated this decrease would result in a substantial degradation of the visual character of the reservoir because of the Class III designation of views at this reservoir, the typical fluctuations of reservoirs, and the land–water interface experience of recreationists. This visual experience would not conflict with existing plans or policies meant to support or maintain existing views. Adaptive implementation is not anticipated to substantially change these effects. Therefore, impacts would be less than significant.

10.4.4 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows in the extended plan area, as described in Chapter 5, *Surface Hydrology and Water Quality*, could potentially impact recreational resources and the visual character and quality of upstream reservoirs on the Stanislaus and Tuolumne Rivers differently in the extended plan area than described in the plan area. Particularly, existing scenic vistas and scenic highways could be affected. These impacts could occur if reservoirs experienced substantial changes in reservoir volume, especially under drought conditions, particularly under LSJR Alternatives 3 and 4 with or without adaptive implementation, which are not experienced by the rim reservoirs. However, under baseline conditions these reservoirs undergo substantial annual water level and volume fluctuations as water is released from the reservoirs for hydropower production, consumptive use, and instream flow requirements (USGS Reservoir Gage Data). Under baseline conditions, these fluctuating reservoir volumes impact recreation at individual reservoirs by reducing the lake area available for boating or fishing, potentially isolating boat ramps and thereby limiting boat access to the reservoir, and potentially isolating swimming beaches from the reservoir. For example, this type of reduction has occurred during the recent drought (UGSG Reservoir Gage Data). However, these volume reductions could occur more frequently, and could be more pronounced during drought conditions, particularly under LSJR Alternative 3 and LSJR Alternative 4 with or without adaptive implementation, but also under LSJR Alternative 2 with adaptive implementation. Consequently, there could be significant recreation impacts at reservoirs under the LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation, in the extended plan area, as explained below.

The aesthetic quality of these reservoirs would be affected when the reservoir levels are drawn down enough the unvegetated rim around their perimeter is visible. Exposure of the unvegetated rim occurs during normal operations; however, as noted above, exposure could occur more frequently under drought conditions, particularly under LSJR Alternatives 3 and 4 with or without adaptive implementation, but also under LSJR Alternative 2 with adaptive implementation. Consequently, there could be significant aesthetic impacts at reservoirs in the extended plan area, as explained below.

There is some potential that drawdown in upstream reservoir storage could result in reduced flows in the fall on the Stanislaus and Tuolumne Rivers. Flow reductions could have a substantial adverse effect on scenic views along the Stanislaus and Tuolumne Rivers if flows are reduced such that viewers (e.g., recreationists) cannot see water in the river and the river becomes less of a feature defining the overall landscape. Flow reductions could substantially degrade the visual character and quality of views of the Tuolumne River, many parts of which are designated as wild and scenic (total 83 miles) (National Wild and Scenic River System 2016). The degradation of views could damage a scenic resource (the river itself) as seen from eligible state scenic highways adjacent to the river (e.g., Highway 49). While no sections of the Stanislaus River are designated as wild and scenic, flow reductions could substantially degrade the visual character and quality of the views of the Stanislaus River, which can be viewed from designated State Scenic Highways 108 and 4 (National Wild and Scenic River System 2016; Caltrans 2016; DOT 2016). Impacts would could be significant, even though higher spring flows and lower fall flows are reflective of what would occur in a natural system. Providing more flows in the fall could mitigate this impact; however, it is counter to each alternative's purpose to provide additional flows during February to June to more closely mimic the natural hydrograph for the protection of fish and wildlife beneficial uses, and is therefore infeasible. There are no other feasible mitigation measures that the State Water Board may impose. Impacts would remain significant and unavoidable.

Many sections of the Merced River are designated wild and scenic (total 122 miles) or within view of designated state scenic highways (Highways 140 and 120) (National Wild and Scenic River System 2016; Caltrans 2016; DOT 2016); however, given the lack of substantial upstream reservoirs, it is unlikely that flow reductions would occur on the Merced River. Therefore, the visual character and quality of the Merced River would not be affected.

Rivers flows on the Stanislaus and Tuolumne Rivers could potentially impact recreational resources in the extended plan area on the Stanislaus and Tuolumne Rivers similar to the impacts described in the plan area. Under LSJR Alternatives 3 and 4 with or without adaptive implementation, the rivers may have higher and more frequent flows when compared to baseline conditions during the bypass period. The higher flows could occur when junior water is bypassed during the snow melt season. As such, on-bank recreational facilities along the three rivers could be inundated more frequently, which could result in the deterioration of facilities. Impacts could be significant. Reducing flows could reduce this impact; however, such a reduction would directly contradict the purpose of these alternatives and is, therefore, infeasible. Owners and operators of on-bank facilities should operate and maintain facilities to minimize the physical deterioration from the increased frequency of inundation, such as increased inspections and repairs; however, the State Water Board lacks authority to impose this mitigation measure, and the impact remains significant. In addition, the combination of snowmelt and possible increases in bypass flows under LSJR Alternatives 3 and 4 with or without adaptive implementation may result in flows that are too high to support in-water recreational uses (e.g., swimming, rafting, kayaking). However, these high flow impacts are expected to be of short duration as the snow pack progressively melts and the related snow-melt flow declines. These impacts are also similar to those that occur under baseline conditions. Conversely, after the bypass period the rivers may have lower flows compared to baseline conditions under LSJR Alternatives 3 and 4 with or without adaptive implementation if reservoir volumes are then low due to the bypassed flow. This could affect in-river recreational uses on the Stanislaus and Tuolumne Rivers.

The increased frequency of lower reservoir levels resulting from the LSJR alternatives and the associated physical changes to recreation and aesthetics would be limited by the program of implementation under each of the LSJR alternatives. The program of implementation requires minimum reservoir carryover storage targets or other requirements to help ensure that providing flows to meet the flow objectives will not have adverse or other impacts on fish and wildlife or, if feasible, on other beneficial uses (i.e., recreation). Other requirements, for example, include, but are not limited to, limits on required bypass flows for reservoirs that store water only for non-consumptive use so that some water can be temporarily stored upstream. The program of implementation also states that the State Water Board will take actions as necessary to ensure that implementation of the flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods. Accordingly, when the State Water Board implements the flow objectives in a water right proceeding, it will consider impacts on fish, wildlife, and, if feasible, on other beneficial uses, and health and safety needs, along with water right priority. Until the State Water Board assigns responsibility to meet the flow objectives in the Bay-Delta Plan, it is speculative to identify the exact extent, scope, and frequency of reduced diversions, reduced reservoir levels and their effects on recreation and aesthetics within the extended plan area. When implementing the flow objectives, the State Water Board would identify project-specific impacts and avoid or mitigate, to the extent feasible, significant impacts of lower reservoir levels on recreation and aesthetics in accordance with CEQA.

At the time of preparation of this programmatic analysis, it is unclear to what extent any significant impacts on recreation and aesthetics could be fully mitigated. Thus, the potential exists for significant impacts. Therefore, this analysis conservatively concludes that impacts associated with lower reservoir levels under LSJR Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with or without adaptive implementation are significant. The following mitigation measure is proposed: when considering carryover storage and other requirements to implement the flow water quality objectives in a water right proceeding, the State Water Board shall ensure that reservoir levels upstream of the rim dams do not cause significant recreation and aesthetic impacts, unless doing so would be inconsistent with applicable laws. Even with mitigation, the impact is considered significant, because the mitigation may not fully mitigate the impact in all situations.

10.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 11
Agricultural Resources

11.1 Introduction

This chapter describes the environmental setting for agricultural resources and the regulatory background associated with these resources. It also evaluates environmental impacts on agricultural resources that could result from the Lower San Joaquin River (LSJR) alternatives and, if applicable, offers mitigation measures that would reduce significant impacts.

LSJR Alternatives 2, 3, and 4 require sufficient flows for the reasonable protection of fish and wildlife beneficial uses. This chapter analyzes those alternatives and assumes that any increases in unimpaired flows[1] would reduce surface water supplies that are available for irrigation purposes. For Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, the analysis then assumes that reduced surface water supplies could potentially lead to reductions in crop acreages, and, where applicable, equates those changes to possible conversions of those lands to nonagricultural uses. It should be noted that this likely presents a more conservative (i.e., "worst case") estimate of potential acreage reduction than may actually occur. Conversions of land to nonagricultural uses are governed by many factors, including the proximity of land to a developable area and the decision of a landowner whether to remain in agriculture. Moreover, the management decisions of individual agricultural producers (farmers) are more sophisticated and driven by more variables than can be accounted for in modeling. For example, land with less irrigation could still remain in agricultural production due to one or more factors, including: efficiency improvements that reduce water demand, crop type or agricultural use changes to less water-intensive applications, dry land farming, or, increased crop rotation among plots of acreage. However, these actions are too speculative to be modeled as they are within the control of the individual farmer, not the State Water Resources Control Board (State Water Board).

This chapter includes assumptions based on past levels of groundwater pumping. Potential impacts on the groundwater subbasins, as a resource, resulting from the LSJR alternatives are addressed in Chapter 9, *Groundwater Resources*. Potential groundwater impacts related to municipal and domestic needs are addressed in Chapter 13, *Service Providers*, and Chapter 22, *Evaluation of Groundwater and Drinking Water Supply of Municipal and Domestic Needs*. Those chapters also reference the recently-passed Sustainable Groundwater Management Act (SGMA), which requires that groundwater basins be locally-managed to ensure reliable levels of groundwater supplies and to prevent continued chronic overdrafting of groundwater basins and other undesirable results.

The LSJR area of potential effects for agricultural resources includes Merced, Stanislaus, and part of San Joaquin Counties. Figure 11-1 identifies the location and type of farmland within the LSJR area

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[1] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

of potential effects. The area of potential effects is based on California Department of Water Resources (DWR) Detailed Analysis Units (DAUs) used in the Statewide Agricultural Production (SWAP) model[2] and is comprised of six geographic areas. These six geographic areas include Stockton East Water District/Central San Joaquin Water Conservation District (SEWD/CSJWCD), South San Joaquin Irrigation District (SSJID), Oakdale Irrigation District (OID), Modesto Irrigation District (MID), Turlock Irrigation District (TID), and Merced Irrigation District (Merced ID).

As described in Chapter 1, *Introduction*, the extended plan area generally includes the area upstream of the rim dams.[3] Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

The SWAP model is a regional economic model for irrigated agricultural production that simulates the decisions of farmers in California. The model assumes that farmers maximize profit subject to resource, technical, and market constraints and that farmers sell and buy in competitive markets in which no one farmer can affect or control the price of any commodity. The SWAP model incorporates project water supplies (State Water Project [SWP] and Central Valley Project [CVP]), other local water supplies, and groundwater in its analysis. SWAP is the best available model for estimating the regional agricultural response to a change in water availability in the LSJR area of potential effects.

However, it should be noted that the SWAP model has limitations. The SWAP model uses a simplified assumption that water use will shift from lower net revenue crops to high-value crops. This means that under the modeling scenarios, irrigation shifts almost completely from Alfalfa and Pasture to higher net revenue crop types. As noted previously, this likely presents a more conservative estimate than may actually occur. The model also calculates the value of the Alfalfa or Pasture as a commodity and cannot factor in its proximity to an affiliated agricultural enterprise such as dairy or beef cattle, which could increase the crop value to an individual producer because of the reduced transportation costs or other factors.

Southern Delta water quality (SDWQ) alternatives are also analyzed throughout this chapter. However, no reduction or conversion of agricultural acreage under the SDWQ alternatives is likely for several reasons. The principle factor influencing water quality in the southern Delta is the salinity level of water coming from the San Joaquin River (SJR) Watershed. However, the program of implementation requires the U.S. Bureau of Reclamation (USBR) to meet and maintain the same salinity requirements that are currently measured at Vernalis on the SJR. Therefore, water quality within the southern Delta is expected to remain unchanged. In addition, as explained in this chapter and Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* under SDWQ Alternatives 2 and 3, even salt-sensitive crops would not be considered significantly impacted. The SDWQ area of potential effects is comprised of agricultural resources in the southern Delta, which are primarily within the boundaries of the Southern Delta Water Agency (SDWA). Figure 11-2 shows the location of the SDWQ area of potential effects and the SDWA boundary with respect to San Joaquin County and the legal boundary of the Delta.

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[2] The LSJR alternatives area of potential effects includes: DAUs 182, 205, 206, 208, and 210.

[3] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

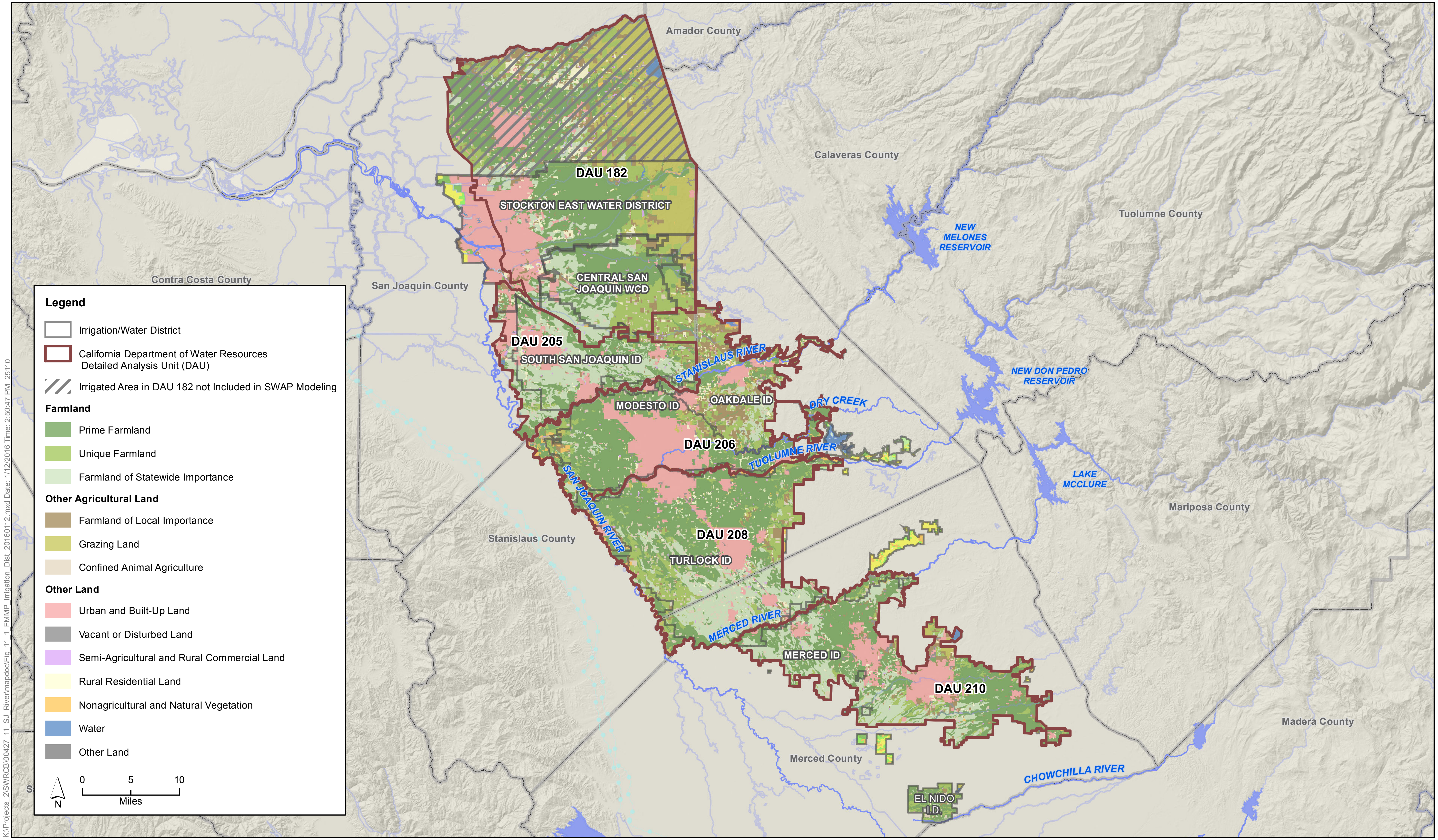

Figure 11-1
Farmland Mapping and Monitoring Program Designations within the LSJR Area of Potential Effects

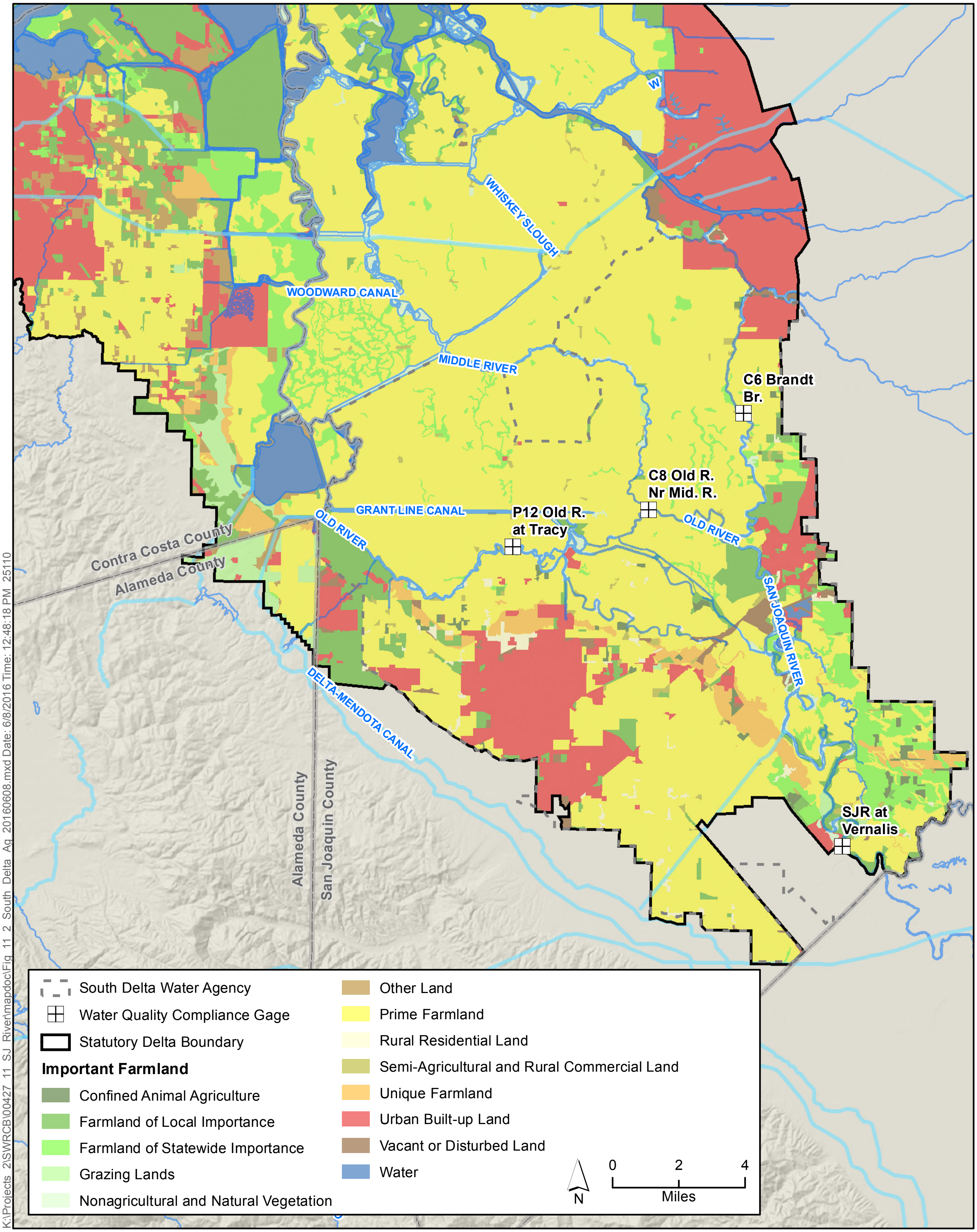

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Figure 11-2
Agriculture within the SDWQ Area of Potential Effects

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Board determined whether the plan amendments would cause any adverse impact for each environmental category in the checklist and provided a brief explanation for its determination. Impacts on agricultural resources that are listed as "Potentially Significant Impacts" are discussed in detail in this chapter. Appendix B, Section II, identified potentially significant impacts of the LSJR and SDWQ alternatives on agricultural resources as: (1) those that result in the conversion of Prime Farmland, Unique Farmland, and Farmland of Statewide Importance (e.g., irrigated farmland); (2) changes in the existing environment which, due to their location or nature, could result in the conversion of farmland to nonagricultural uses; or (3) those that conflict with existing zoning for agricultural uses or Williamson Act contracts. In addition, Appendix B, Section X identified potentially significant impacts of the LSJR and SDWQ alternatives as those that conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over a project adopted for the purpose of avoiding or mitigating an environmental effect.[4]

As noted previously, this evaluation generally focuses on the potential conversion of irrigated farmland to nonagricultural uses as a result of a reduction in surface water supplies (LSJR alternatives) or a change in water quality (SDWQ alternatives). Impacts associated with the LSJR alternatives were assessed using the State Water Board's Water Supply Effects (WSE) model and the SWAP model to determine whether reduction in surface water diversions for crop production in the LSJR area of potential effects or a change in water quality could result in a change in the distribution of crops or crop production. The analysis uses this information to qualitatively discuss the potential conversion of designated agricultural lands to nonagricultural land. The qualitative assessment of impacts associated with the SDWQ alternatives on agricultural resources was based on the expected water quality in the southern Delta under the different alternatives, in conjunction with the LSJR alternatives, and the tolerance of salt-sensitive crops in the southern Delta.

A summary of the potential impacts of the LSJR and SDWQ alternatives on agricultural resources is provided in Table 11-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 each include four methods of adaptive implementation. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under a LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 11-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*. Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to compliance and methods of compliance.

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[4] This language is applicable when put in an agricultural context.

Table 11-1. Summary of Agricultural Resources Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact AG-1: Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternative 2	Potential environmental impacts from the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use are less than significant under LSJR Alternative 2 without adaptive implementation because potential reductions in surface water diversions could result in a less than 4% average reduction in irrigated acreage for the irrigation districts in the LSJR area of potential effects. However, if adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%), environmental impacts would be potentially significant and unavoidable as it is estimated that OID could experience a 4.4% average reduction in irrigated crops, which equates to 2,356 acres receiving reduced irrigation, and MID could experience a 4.5% average reduction in irrigated crops, which equates to 2,589 acres receiving reduced irrigation. It is reasonable to assume that a portion of the reduced irrigated acreage is Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, and that some portion of acreage with reduced irrigation could potentially be converted to nonagricultural uses even though there are many factors affecting whether land is converted. Conversely, land can be maintained in agricultural use through crop substitution, crop rotation, fallowing, and dry land farming.	Less than significant	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternative 3	Environmental impacts from the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses are considered potentially significant and unavoidable because approximately 22,879 acres, on average, of Prime or Unique farmland or Farmland of Statewide Importance requiring irrigation could have reduced surface water diversions, and it is reasonable to assume that a portion could potentially be converted to nonagricultural uses, even though there are many factors affecting whether land is converted. Conversely, land can be maintained in agricultural use through crop substitution, crop rotation, and dry land farming. Specifically, reductions in surface water diversions could result in reduced acres of irrigated land for Alfalfa for SSJID, MID, and TID; Grain in MID; Field Crops in SSJID, MID and TID; Pasture in SSJID, OID, MID, and TID; Rice in SSJID and MID; and Dry Beans and Processing Tomatoes in SSJID. Those potential average reductions in irrigated acreage range from 0.8% for Merced ID to 9.9% for MID.	Significant and unavoidable	Significant and unavoidable
LSJR Alternative 4	Environmental impacts from the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses are potentially significant and unavoidable because approximately 70,640 acres, on average, of Prime or Unique Farmland or Farmland of Statewide Importance requiring irrigation could have reduced surface water diversions, and it is reasonable to assume that a portion could potentially be converted to nonagricultural uses, even though there are many factors affecting whether land is converted. Conversely, land could be maintained in agricultural use through the crop substitution, crop rotation, and dry land farming. Specifically, reductions in surface water diversions could result in reduced acres of irrigated land for Alfalfa, Pasture, Corn, Grain, and Field in SSJID, OID, MID, and Merced ID; Rice and Safflower in SSJID, OID, and MID; Dry Bean and Cucurbits in	Significant and unavoidable	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	SSJID, OID, MID, and Merced ID; Processing and Fresh Tomato and Truck in SSJID, and Truck in SSJID, MID, and TID. Those potential average reductions in irrigated acreage range from 2.6% for Merced ID to 27.5% for MID.		
SDWQ Alternatives 2 and 3	No reduction or conversion of agricultural acreage is likely because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.	Less than significant	NA
Impact AG-2: Involve other changes[c] in the existing environment which, due to their location or nature, could result in a conversion of farmland to nonagricultural use			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternative 2	Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced.	Less than significant	Less than significant
LSJR Alternative 3	Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced. Given cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies, as an agricultural use, would be converted to nonagricultural uses.	Less than significant	Less than significant
LSJR Alternative 4	Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced. Given cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	equitable distribution of local water suppliers, it is unlikely dairies, as an agricultural use, would be converted to nonagricultural uses		
SDWQ Alternatives 2 and 3	Conversion of farmland to nonagricultural use is not expected because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.	Less than significant	NA
Impact AG-3: Conflict with existing zoning for agricultural use or a Williamson Act contract			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	The LSJR alternatives would not conflict with existing zoning for agricultural use or Williamson Act contracts because the LSJR alternatives would not change zoning and lands that are under Williamson Act contracts must be maintained in the compatible uses specified in those contracts until non-renewed, canceled or otherwise withdrawn from contract. Lands that experience a reduction in surface water supply could be dryfarmed, rotated, or fallowed, all of which would be agricultural activities that are consistent with agricultural zoning and Williamson Act contracts.	Less than significant	Less than significant
SDWQ Alternatives 2 and 3	The SDWQ alternatives would not conflict with existing zoning for agricultural use or Williamson Act contracts because the SDWQ alternatives would not change zoning, and agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.	Less than significant	NA
Impact AG-4: Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternatives 2, 3, and 4	The LSJR alternatives would not conflict with applicable land use plans, policies, or regulations because the LSJR alternatives are not proposing amendments to existing land use plans, policies, or regulations. While some agricultural land could be taken out of irrigated agricultural use as a result of the LSJR alternatives (particularly LSJR Alternatives 3 and 4), many of these lands could remain in agricultural use, even if they are not irrigated and must remain in uses that are compatible with applicable local land use plans, policies or regulations.	Less than significant	Less than significant
SDWQ Alternatives 2 and 3	The SDWQ alternatives would not conflict with applicable land use plans, policies, or regulations because the SDWQ alternatives would not change zoning, and agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.	No impact	NA

CSJWCD = Central San Joaquin Water Conservation District
LSJR = Lower San Joaquin River
Merced ID = Merced Irrigation District
MID = Modesto Irrigation District
NA = not applicable
OID = Oakdale Irrigation District
SDWQ = southern Delta water quality
SEWD = Stockton East Water District
SSJID = South San Joaquin Irrigation District
TID = Turlock Irrigation District
USBR = U.S. Bureau of Reclamation

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 11.4.2, *Methods and Approach*, of this chapter. There is no adaptive implementation or adaptive implementation methods for the SDWQ alternatives.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives established in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project Alternative technical analysis.

[c] The "other changes" to the existing environment included in the Impact AG-2 analysis are high water tables that could potentially affect fields due to seepage and potential reductions in farmland upon which other agricultural production relies.

11.2 Environmental Setting

This section characterizes the agricultural resources in the LSJR area of potential effects and SDWQ area of potential effects (or SDWA). The description of agricultural resources includes soils, farmland, crop mix, methods of irrigation, drainage, and water supply and describes the connection between crop production and water quality. General information regarding soil and water quality is first discussed to provide context for crop production in the LSJR area of potential effects and SDWQ area of potential effects. Information on soils and farmland is from the Natural Resources Conservation Service (NRCS) and the California Department of Conservation (DOC); crop production and cropping trends are from DWR land use surveys; water supply and quality information is from previous chapters in this document. Additionally, the current state of knowledge for salinity and its applicability to the LSJR area of potential effects and SDWQ area of potential effects is fully discussed in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*.

11.2.1 Soil and Water Quality

Soils are intrinsic features of a landscape. They develop over time through physical, chemical, and biological processes. In the LSJR area of potential effects and SDWQ area of potential effects, the suitability of soils to support agricultural enterprises is classified by NRCS and is based on the soil type, adequate drainage, and the availability of water supply for irrigation. The State of California uses this information to develop maps that identify Prime Farmland, Farmland of Statewide Importance, and Unique Farmland. In addition, counties may identify Farmland of Local Importance. The definitions for each of the land use categories are provided in Section 11.3.1, *State [Regulatory Background]*.

All waters contain soluble salts, collectively referred to as *salinity*. The major components of either water or soil salinity include cations (calcium, sodium, and magnesium) and anions (bicarbonate, chloride, and sulfate) (Ayers and Westcott 1985). With regards to soil, salinity refers to the soluble plus readily dissolvable salts in the soil or in an extract of a soil sample. Salinity is quantified in terms of the total concentration of soluble salts. In practical terms, salinity is measured as electrical conductivity (EC)[5] of the solution (USDA 1954).

Salts in soil are generally at higher concentrations than those found in water. The extent to which salts accumulate in the soil depends on the irrigation water quality, irrigation management, and the adequacy of drainage. Crop water use (evapotranspiration) of irrigation water results in a salt load to the soil because crop evapotranspiration removes water from the soil profile but leaves the salt. Although crops uptake salt, the amount is insignificant. If salts in the soil become excessive, crop yield could be reduced. Certain crops may also have specific ion toxicities, where even relatively low concentrations of the ion could lead to yield reductions. Factors to consider when establishing a salinity standard for irrigated agriculture include plant response to soil salinity, effective rainfall, and irrigation management and method. Another important factor is that a plant's sensitivity to soil

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[5] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

salinity changes during plant development. Many crops are most sensitive to soil salinity during emergence and early seedling development (Ayers and Westcott 1985; USSL 2011).

The method of irrigation and water management affects how a plant tolerates water or soil salinity. The main methods of irrigation in the LSJR Watershed and southern Delta include surface (border strip, furrow, and basin), sprinkler, and micro-irrigation (Edinger-Marshall and Letey 1997). In some areas of the southern Delta, subirrigation is also practiced. Poorly managed border and furrow irrigation can cause salt to build up in the soil profile in areas that do not receive adequate irrigation water of sufficient quality. Salt buildup can occur with micro-irrigation if the systems are not properly managed to push salts away from the rootzone. Subirrigation causes salt to build up in the top portion of the soil profile, unless this is flushed with surface irrigation or precipitation (Grattan 2002).

To reduce salinity impacts on crops, a leaching fraction is added to the crop's irrigation water requirement. The amount of water used for leaching is considered a beneficial use and is based on a plant's salinity tolerance and the salinity of the irrigation water. However, depending on the efficiency of the irrigation system being used and the effectiveness of rainfall, the leaching requirement may be inherently satisfied through irrigation inefficiency.

11.2.2 Lower San Joaquin River Watershed and Eastside Tributaries

This section summarizes the types of farmland and recent changes in farmland acreage, land subject to Williamson Act contracts, crop production, and water supply in the LSJR area of potential effects.

Types of Farmland

The LSJR area of potential effects covers more than 1 million acres of agricultural lands in California's San Joaquin Valley. The majority (55 percent) of farms in the San Joaquin Valley are less than 100 acres, while approximately 20 percent of farms are between 100 and 250 acres (Agricultural Water Management Council 2010). Statewide, the average farm size is 312 acres (DFA 2010).

The majority of land (65 percent) in the LSJR area of potential effects is designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Table 11-2). These lands are designated as such because of certain positive qualities, such as good soil characteristics like drainage, and the availability, amount, and frequency of irrigation. The lands must be irrigated 8 out of every 10 years and there must be adequate depth to the water table to support commonly cultivated crops.

Table 11-2 identifies the total acres of the various farmland categories within the LSJR area of potential effects organized by the six geographic areas that receive surface water supplies from the Stanislaus, Tuolumne, and Merced Rivers: SEWD/CSJWCD, SSJID, OID, MID, TID, and Merced ID. Figure 11-1 identifies the location and type of farmland within the LSJR area of potential effects. Although Table 11-2 shows total acres, including nonagricultural land, for the six geographic regions, typically the respective water districts supply only the farmland portion of each region with irrigation water.

Table 11-2. California Department of Conservation's Land Use Classification Acreages in the LSJR Area of Potential Effects

Land Use Category	SEWD and CSJWCD	SSJID	OID	MID	TID	Merced ID	Total Acres
Prime Farmland	79,648	20,021	11,370	50,186	82,466	67,566	311,257
Unique Farmland	23,754	4,190	18,625	5,871	22,142	10,219	84,802
Farmland of Statewide Importance	20,647	29,408	6,905	2,057	36,788	35,930	131,734
Total Designated Farmland[a]	124,049	53,619	36,900	58,114	141,396	113,715	527,793
Farmland of Local Importance	11,532	3,004	16,984	2,784	3,956	8,390	46,650
Semi-Agricultural and Rural Commercial Land	736	466	540	481	794	687	3,702
Urban and Built-Up Land	47,730	12,674	6,163	28,743	23,725	23,154	142,190
Rural Residential Land	4,514	1,578	3,875	1,864	3,813	2,091	17,735
Grazing Lands	22,490	0	3,975	3,674	1,835	2,129	34,103
Confined Animal Agriculture	1,868	728	2,458	1,362	8,395	2,863	17,675
Nonagricultural and Natural Vegetation	1,263	205	1,357	2,192	1,203	403	6,623
Vacant or Disturbed Land	2,167	312	594	690	1,440	1,420	6,623
Water	726	0	286	2,011	0	429	3,453
Total Land	217,075	72,586	73,133	101,915	186,558	155,280	806,547
Percent Total Designated Farmland of Total Land	57%	74%	50%	57%	76%	73%	65%

Source: DOC 2012.

SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Control District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

[a] The sum of Prime Farmland, Unique Farmland, and Farmland of Statewide Importance.

The LSJR area of potential effects, like other parts of the Central Valley and California, has generally experienced a decline in agricultural lands in the past 20 years. Table 11-3 identifies the change in the acreages of Prime Farmland, Unique Farmland, Farmland of Statewide Importance, and Farmland of Local Importance in San Joaquin, Stanislaus, and Merced Counties. San Joaquin County had a relatively large reduction of Prime Farmland from 1990 to 2012, resulting in a correspondingly large net loss of farmland overall. Total farmland area in Merced County remained mostly unchanged from 1992 to 2012, but there was still a large reduction of Prime Farmland. On the other hand, from 2004 to 2012, Stanislaus County had a net gain in total farmland area, primarily because lost Prime Farmland was offset by a large increase of Unique Farmland.

Table 11-3. Changes in Prime Farmland, Unique Farmland, and Farmland of Statewide and Local Importance (Acres)

Land Use Category	San Joaquin County (1990–2012)	Stanislaus County (2004–2012)	Merced County (1992–2012)
Prime Farmland	-55,744	-10,321	-17,105
Farmland of Statewide Importance	-18,116	2,017	-8,687
Unique Farmland	25,194	25,053	15,606
Farmland of Local Importance	23,261	-3,719	10,142
Total	-25,405	13,030	-44

Source: DOC 2015a.

Note: Data include the entire counties, and therefore it is assumed that changes in the LSJR area of potential effects are proportional in the LSJR area of potential effects portion of the respective county.

Farmland Conversion

Like many of California's inland areas, the San Joaquin Valley is likely to experience urbanization on an unprecedented scale. As California grows, much of its growth will be accommodated in crowded metropolitan coastal areas and in Southern California's Inland Empire (PPIC 2005). But spillover from the Bay Area is causing growth stress in the San Joaquin Valley as commuters seek affordable housing. Over the past 35 years, the northern San Joaquin Valley, including San Joaquin, Stanislaus and Merced Counties, has experienced explosive growth in the numbers of workers who commute north and west out of the valley each day. By 2010, that was estimated to be about 24 percent of workers working outside their county of residence with about 46,000 heading towards the Bay Area (Stevens 2014). In addition to the Bay Are growth shift, the San Joaquin Valley is experiencing major growth in its own right—doubling in population approximately every 30 years since 1900. To accommodate that growth, the Public Policy Institute of California estimated that an additional 1 million acres or more of land would be converted by 2040, which would triple the current amount of urbanized land to accommodate new development and reduce farmland by at least 15 percent overall (PPIC 2005). Under DWR projections, irrigated acreage in the San Joaquin Valley declines on average from a low of 117,000 acres by year 2050 to a high of approximately 272,000 acres relative to a 2006 base-year footprint of approximately 1.9 million acres. In other words, declines of between 6 percent and 14 percent of the irrigated acreage (DWR 2014).

Historically, in the San Joaquin Valley, more than 60 percent of all land developed is high quality farmland (Prime, Unique, or Farmland of Statewide Importance), even though that land is only 40 percent of all land in the region. In the LSJR area of potential effects for agricultural resources, the impacts are even higher with development in San Joaquin, Stanislaus, and Merced Counties occurring on high-quality farmland at rates of 76 percent, 83 percent, and 63 percent, respectively, of all land urbanized between 1990 and 2004. The disproportionate impact of urbanization on the best farmland is because most California cities were located in areas with good soils and abundant water, and most development occurs in the immediate urban fringe. In addition, while statewide growth has consumed an acre of land for every 9.4 people (and even less in places like Sacramento where it is about 20 people per acre), the San Joaquin Valley has consumed land at the rate of an acre for every 8 people and, if rural residential ranchettes are included, the development efficiency figure drops even lower. This makes rapid city-centered growth and inefficient land use the underlying causes of most farmland conversion (AFT 2007).

While urbanization isn't the only pressure causing conversions to nonagricultural use in the San Joaquin Valley, it is the greatest pressure in the potential area of effects for agricultural resources. Other large scale pressures, such as salt buildup, are occurring outside the potential area of effects. For example, the San Joaquin Valley Drainage Relief Act identifies 75,000 acres of irrigated agricultural lands on the west side of the San Joaquin Valley that should be retired by the year 2040 primarily due to characteristics of low productivity, poor drainability, and high levels of selenium in shallow groundwater. (Wat. Code, § 14900 et seq.)

Williamson Act Contracts

The Land Conservation Act of 1965, commonly referred to as the Williamson Act, provides a statutory framework for local implementation of farm and ranch land preservation, protecting over 16.4 million acres or nearly one-third of all privately owned land in California. The Williamson Act discourages premature and unnecessary conversion of agricultural land to urban uses through an interrelated set of property tax, land use, and conservation measures. Under the Williamson Act, a landowner enters into a contract with the local government wherein he or she foregoes the possibility of development, or converting his or her property into nonagricultural or non-open space use, during the term of the contract. In return he or she receives lower property taxes. A 1989 analysis of the program showed an average tax savings of 44 percent for tree and vine land up to 70 percent for grazing land (DOC 1989). In a 2012 study, 91 percent of the ranchers polled stated Williamson Act tax reductions were either "very important" or "extremely important" for the "long term viability of their cattle and rangeland operations" and that for 71 percent of the Williamson Act-enrolled ranchers, their net annual profit was equal or less than their Williamson Act property tax savings in 2009 (Wetzel 2012). Although local governments forego a portion of property taxes due to Williamson Act valuations, in return they receive planning advantages and values implicit in retaining or open space.

Land Conservation Act contracts are for rolling 10-years terms, meaning they renew automatically each year for another 10 year term. There is also a rolling 20-year contract option called a Farmland Security Zone contract, also known as a "Super Williamson Act" contract. Until 2010, the state made Open Space Subvention payments from the state general fund to local governments to offset a portion of Williamson Act-related reduced revenues. Those payments totaled $863 million between 1971 and 2010, or almost $1.5 billion when adjusted for inflation. Starting fiscal year 2010–11 Open Space Subvention payments were effectively eliminated. In response, the legislature passed Assembly Bill (AB) 1265, which allows participating counties to recapture a portion of foregone property tax revenue by decreasing the duration of contracts to 9 years for regular Land Conservation Act contracts or 18 years for Farmland Security Zone contracts. Also in 2011, the legislature passed Senate Bill (SB) 618, providing an option to rescind Land Conservation Act contracts on land that has been compromised due to chemical, physical, or water-related limitations and replace the contracts with Solar-Use Easements. Within the past decade, the nonrenewal of Williamson Act contracts, often viewed as a precursor to converting farmland to other uses, occurred in response to economic trends with nonrenewal peaking in 2007 at 157,805 acres. Following that period, as the recession slowed the demand for urban expansion, nonrenewal initiation acreages fell sharply to 19,967 acres in 2010. In 2011, the elimination of Open Space Subvention payments led Imperial County to initiate nonrenewal on all 117,246 acres remaining under contract (DOC 2015b).

There are approximately 377,999 acres under Williamson Act contracts in the LSJR area of potential effects (DOC 2009, 2010a) with Merced and Stanislaus Counties participating in the AB 1265 option for reduced contract terms. Table 11-4 identifies the acreages under Williamson Act contracts within each of the six geographic areas.

Table 11-4. Acreages under Williamson Act Contract in the LSJR and SDWQ Areas of Potential Effects

Areas of Potential Effects	Williamson Act Land
LSJR Area of Potential Effects	
SEWD/ CSJWCD	121,439
SSJID	26,172
OID	46,503
TID	103,834
MID	43,984
Merced ID	36,065
Total	377,999
SDWQ Area of Potential Effects	
Total	83,614

Source: DOC 2009, 2010a.

LSJR = Lower San Joaquin River
SDWQ = southern Delta water quality
SEWD/CSJWCD = Stockton East Water District/Central San Joaquin Water Conservation District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

Crop Production

Farmland in the LSJR area of potential effects is irrigated by surface water diversions from the three eastside tributaries[6] and from groundwater.

Dryland farming, which relies on stored water in the soil, is feasible for some annual crops in the LSJR area of potential effects (Luers 1970). Dryland farming acreage information is not collected by the Farmland Mapping Program (DOC 2009, 2010a) or reported in the agricultural water management plans for the irrigation districts in the LSJR area of potential effects; as a result, the full extent of the practice is unknown. The acreage reported for planted and harvested winter wheat can be used to estimate dryland farming because this type of crop can be dryland farmed in the LSJR area of potential effects. In 2011, Merced County harvested 20,800 acres of 36,000 acres of winter wheat that were planted, San Joaquin County harvested 26,000 acres of the 36,500 acres of winter wheat that were planted, and Stanislaus County harvested 3,200 acres of the 12,000 acres of winter wheat that were planted (USDA 2012). No acreage was planted in any county in 2013 (USDA 2013). While winter wheat acreage is useful to characterize the practice of dryland farming, there is the potential that winter wheat may be irrigated. In such cases, these estimates would potentially overestimate the amount of dryland acres.

On a periodic basis, DWR surveys and catalogs irrigated acreage into 19 crop categories and provides this data organized by DAU. Irrigated crop production within the LSJR area of potential effects is diverse, with a wide variety of crops grown on 516,727 acres (Table 11-5). Table 11-6 shows the percentage of each of the 19 crop categories within each irrigation district and illustrates how cropping patterns differ between districts.

Cultural crop practices in the LSJR area of potential effects include crop rotation and fallowing (Marsh and Jackson 2006). However, the extent of fallowed land and crop rotation cannot be quantified because this type of data is not readily available and is not reported in the irrigation districts' agricultural water management plans. Crop rotation involves the use of the same piece of land cultivated for various crops, such as corn followed by winter wheat. Land fallowing, or removing land from agricultural production for a period of time, is the deliberate idling of land for a cultural crop practice, such as disease control. Fallowed land is typically managed to keep down weed growth (Marsh and Jackson 2006).

Other Agricultural Production

In addition to crop production, the other significant agricultural activity in the LSJR area of potential effects is dairy. In California there are approximately 1,563 dairies, of which 578 are located in Merced, Stanislaus, and San Joaquin Counties. This is approximately 36 percent of the state's total dairy operations (USDA 2015). Confined animal agriculture acreage is approximately 17,675 acres in the LSJR area of potential effects (Table 11-2); however, the breakdown of this acreage into dairy and other feed operations is unknown because the data is collected based on the definition of confined animal agriculture and does not distinguish between dairies and other confined animal operations. The total value of dairy in the LSJR area of potential effects in 2013 was $2.2 billion (USDA 2015).

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[6] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

Dairies in the LSJR area of potential effects use water for herd and facility management and for waste disposal. Local crop production allows for both feed and waste disposal for dairies within the LSJR area of potential effects. Dairy relies on Alfalfa and Corn for feed and, to some extent, pasture for grazing. Waste disposal is typically on cropland that is adjacent to dairy facilities. Cropland that is used for disposal may be used for production of feed crops such as Corn, Grain, or Pasture. Water used for waste disposal is to help manage the salt and nitrate loading to lands and local groundwater. Dairy operations in the LSJR area of potential effects operate under waste discharge permits issued by the Central Valley Regional Water Quality Control Board (Cady and Francesconi 2010). In 2015, a critically dry year, irrigation water cost for dairy feed in the San Joaquin Valley represent about 9 percent of the cost of farm milk production (Sumner 2016). Although this is a major cost, it is not itself dominant when considering other costs associated with dairies (Sumner 2016).

Beef cattle operations are also located in the LSJR area of potential effects, representing about 11 percent of the state's total beef cattle inventory of 600,000. There are three segments to beef cattle operations: cow-calf, feeder cattle, and feedlot operations. Cow-calf and feeder cattle operations typically rely on winter pasture and some irrigated pasture for grazing in the summer. In contrast, feedlots rely on grains and oilseed from out of state and, therefore, do not rely on feed directly produced in the LSJR area of potential effects (Medellin-Azuara et al. 2016).

Table 11-5. Crop Production in the LSJR Area of Potential Effects by DAU (Acres)

	SEWD and CSJWCD (DAU 182)	SSJID (DAU 205)	OID (DAU 206)	MID (DAU 206)	TID (DAU 208)	Merced ID (DAU 210)
Crop Category	Acres					
Alfalfa	6,893	3,175	2,131	2,674	14,371	5,810
Almonds and Pistachios	17	27,032	10,513	13,157	33,776	30,615
Corn	16,098	8,332	9,758	10,525	43,350	19,088
Cotton	0	0	0	0	0	2,490
Cucurbits	819	490	101	127	469	646
Dry Bean	770	175	214	255	1,073	0
Field Crops	0	210	7,806	9,422	29,078	7,193
Fresh Tomato	8,066	70	0	0	379	1,844
Grain	8,310	1,670	376	212	455	3,135
Onion and Garlic	179	602	0	0	0	0
Orchards	43,161	6,854	6,504	8,149	8,238	4,887
Pasture	4,057	1,664	8,839	8,743	4,784	5,994
Rice	0	84	4,250	679	0	1,199
Safflower	0	162	0	0	0	0
Subtropical Crops	0	1,747	137	42	63	0
Sugarbeet	0	0	0	0	0	277
Tomato (Processing)	0	454	0	0	0	1,383
Truck Crops	1,124	437	2,807	3,523	7,977	11,803
Vine	9,485	5,393	879	1,103	2,016	3,873
Total by District	98,979	58,551	54,315	58,611	146,029	100,237
Total All Districts						516,722

Source: Table G.4-3, Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Notes: The total district irrigated acres is from the districts' agricultural water management plans, while the distribution of crops is based on DWR DAU crop data. See Appendix G, Section G.4.2, *Crop Distribution and Applied Water Inputs for SWAP*, for more details.

DAUs are typically river basin- and irrigation district-specific.

Each crop category is a consolidation of several different crop types. For example, Grain includes barley, wheat, and oats.

SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Control District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District
DAU = California Department of Water Resources Detailed Analysis Units

Table 11-6. Crop Production in the LSJR Area of Potential Effects by DAU (Percent)

Crop Category	SEWD and CSJWCD (DAU 182)	SSJID (DAU 205)	OID (DAU 206)	MID (DAU 206)	TID (DAU 208)	Merced ID (DAU 210)
	% of Irrigated Cropland					
Alfalfa	7.0	5.4	3.9	4.6	9.8	5.8
Almonds and Pistachios	0.0	46.2	19.4	22.4	23.1	30.5
Corn	16.3	14.2	18.0	18.0	29.7	19.0
Cotton	0	0	0	0	0	2.5
Cucurbits	0.8	0.8	0.2	0.2	0.3	0.6
Dry Bean	0.8	0.3	0.4	0.4	0.7	0
Field Crops	0.0	0.4	14.4	16.1	19.9	7.2
Fresh Tomato	8.1	0.1	0	0	0.3	1.8
Grain	8.4	2.9	0.7	0.4	0.3	3.1
Onion and Garlic	0.2	1.0	0	0	0	0
Orchards	43.6	11.7	12.0	13.9	5.6	4.9
Pasture	4.1	2.8	16.3	14.9	3.3	6.0
Rice	0	0.1	7.8	1.2	0	1.2
Safflower	0	0.3	0	0	0	0
Subtropical Crops	0	3.0	0.3	0.1	0	0
Sugarbeet	0	0	0	0	0	0.3
Tomato (Processing)	0	0.8	0	0	0	1.4
Truck Crops	1.1	0.7	5.2	6.0	5.5	11.8
Vine	9.6	9.2	1.6	1.9	1.4	3.9
Total	100	100	100	100	100	100

Source: Adapted from Table G.4-3, Appendix G, *Agricultural Economic Effects of the lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

DAU = California Department of Water Resources Detailed Analysis Units
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Control District
SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

Water Supply, Irrigation, and Water Quality

Surface water supply for irrigation in the LSJR area of potential effects is provided to agricultural users by organized irrigation and water (conservation) districts (collectively referred to as the *irrigation districts* throughout the rest of this chapter). These irrigation districts regularly receive surface water from the Stanislaus, Tuolumne, and Merced Rivers. In addition to surface water supply provided by irrigation districts, many growers have access to groundwater. Details on surface water supply availability and groundwater supply to irrigation and water districts are discussed in Chapter 2, *Water Resources,* Chapter 9, *Groundwater Resources*, and Chapter 13, *Service Providers*.

Irrigation district operations are generally based on diverting river flow into open channels that provide service to parcels of various sizes (Merced ID 2013; MID 2012; OID 2012; TID 2012). Typically, surface water irrigation deliveries begin in April and continue through September, with peak delivery in the summer months. Water can be delivered to a farm on various terms – for example, it can be delivered on a rotating schedule with a fixed flow rate and duration or a user-requested schedule with a variable flow rate and duration. In addition, some irrigation districts operate canals and make deliveries in the off-season for groundwater recharge.

In general, irrigation districts state that they emphasize equity and fairness in the distribution of surface water supplies during normal and dry periods (Merced ID 2013; OID 2012, TID 2012). Irrigation districts acknowledge an increase in groundwater pumping by growers during normal and dry periods, as well as some level of groundwater overdraft, to meet on-farm flexibility needs when surface water supplies are not enough (Merced ID 2013; MID 2012; OID 2012; TID 2012). Merced ID reported in its 2012 Agricultural Water Management Plan that it meets shortages in surface water through increased groundwater pumping (Merced ID 2013). TID allows for internal water transfers but does not distinguish between crop types when making surface water supply allocations (TID 2012).

On-farm irrigation methods in the LSJR area of potential effects include surface, sprinkler, drip, and micro-irrigation (Table 11-7) (DWR 2010). Sometimes other methods of irrigation are used, such as subirrigation, in which the water table is controlled (Table 11-7) (DWR 2010). For the most part, higher net value crops, such as Trees and Vines, are irrigated with pressurized systems, such as hand-moved sprinklers or micro-sprayers. Generally, crops that produce lower net revenue per acre, such as Grains and Pasture, are irrigated with surface methods.

Table 11-7. Irrigation Method Types in Merced, San Joaquin, and Stanislaus Counties (Percent)

County	Surface	Sprinkler	Drip and Micro	Other
Merced	57.2	6.2	34.0	2.7
San Joaquin	36.0	14.2	36.6	13.2
Stanislaus	44.1	9.5	44.8	1.6

Source: DWR 2010.

Surface water quality is very good in the three eastside tributaries, with an average salinity (ECw) value of less than 0.1 deciSiemens per meter (dS/m), as discussed in Chapter 5, *Surface Hydrology and Water Quality*. Groundwater quality in the LSJR area of potential effects varies depending on the groundwater basin, hydrogeology, and depth to groundwater, as discussed in Chapter 9, *Groundwater Resources*. In general, groundwater is known to have elevated salt and nitrate concentrations in the LSJR area of potential effects. However, groundwater within the three eastside tributary watersheds is considered to be of higher quality than for other locations because it is recharged by snowmelt from the Sierra Nevada, which has a low concentration of dissolved constituents.

11.2.3 Extended Plan Area

There are limited agricultural resources in the extended plan area and no designated Prime, Unique, or Farmland of Statewide Importance (California Farmland Mapping and Monitoring Program n.d.). Much of the extended plan area is designated as nonagricultural, but there is some acreage in grazing in Mariposa County near Lake McClure (California Farmland Mapping and Monitoring Program webpage). There are individual small water rights used for irrigated pastures, orchards, and occasional vineyards.

11.2.4 Southern Delta

This section summarizes the agricultural features within the SDWQ area of potential effects, including the farmland classification and acreage, the Williamson Act contract acreage, and the total crop production for different crop types. This section also summarizes water supply, irrigation methods, and water quality in the SDWQ area of potential effects within the boundary of the SDWA. Figure 11-2 shows the location of the SDWQ area of potential effects and the SDWA boundary with respect to San Joaquin County and the legal boundary of the Delta.

Prior to development, lands in the SDWQ area of potential effects existed in a natural state with both organic and mineral soils (NRCS 1999). Over many millennia, histosols, commonly known as organic soils, peats, or mucks, developed in the Delta as plants grew and died. Delta reclamation took place between 1900 and 1920 on lands in the Delta's interior. When adequate drainage was provided to these lands, microbial oxidation of the organic material began, resulting in loss of soil volume (subsidence) over time. Soil subsidence is compounded by wind erosion. Depending on the location, subsidence and erosion rates of 0.5–1.5 inches per year can be common in certain areas. Since the early 1900s, as much as half of the original accumulated soil volume has been lost. The result of the reclamation efforts is largely what is seen as the Delta today—approximately 700 miles of waterways and 1,100 miles of levees that protect over 538,000 acres of farmland, homes, and other structures (DWR 2009).

Types of Farmland

As depicted on Figure 11-2 and described in Table 11-8, the majority of agricultural land in the SDWQ area of potential effects is classified as Prime Farmland (DOC 2012).

Table 11-8. California Farmland Mapping Program Land Use Classification for the SDWA (2010)

Land Use Classification	Acres
Prime Farmland	98,563
Unique Farmland	4,890
Farmland of Statewide Importance	8,079
Farmland of Local Importance	9,071
Semi-Agricultural and Rural Commercial Land	1,255
Urban and Built-Up Land	16,186
Rural Residential Land	1,592
Grazing Lands	447
Confined Animal Agriculture	1,213
Nonagricultural and Natural Vegetation	3,942
Vacant or Disturbed Land	1,930
Water	227
Total	147,396

Source: DOC 2012.

SDWA = Southern Delta Water Agency

Some Prime Farmland in San Joaquin County (Table 11-3) has undergone conversion to urban and other lands (California Department of Conservation 2015).

Farmland Conversion

For over 20 years, the Delta has been recognized as an agricultural region and open-space region of great value to the state and nation and that retention and continued cultivation and production of its fertile peatlands and prime soils are of significant value. In response, the Legislature passed the Johnston-Baker-Andal-Boatwright Delta Protection Act of 1992. (Pub. Resources Code, § 29700 et seq.) The act created the Delta Protection Commission and, as updated in 2009, required the commission to adopt a resources management plan for the Delta region by October 1, 1994 that addressed, among its mandatory requirements, how to protect the Delta from any development that results in significant loss of habitat or agricultural land. (Pub. Resources Code, § 29760.) The Delta Protection Act is discussed in more detail below under Section 11.3.1, *State [Regulatory Background]*. However, as no reduction or conversion of agricultural acreage under the SDWQ alternatives is likely, potential farmland conversion pressures in the Delta are not discussed further here.

Williamson Act Contracts

There are approximately 83,614 acres under Williamson Act contracts in the SDWQ area of potential effects (Table 11-4), representing about 84 percent of the total agricultural acreage. Further discussion of the Williamson Act can be found in Section 11.3.1, *State [Regulatory Background]*.

Crop Production

A wide variety of crops are grown on over 100,000 acres in the SDWQ area of potential effects (Table 11-9) (DWR 2005). Agricultural uses in the southern Delta currently divert water from existing waterways, expecting it to be of suitable water quality to irrigate various different crops. About 60 percent of the land is cultivated as annual crops (Truck & Berry, Field Crops, and Grain & Hay). Alfalfa is cultivated on roughly 30 percent of the land. There has been about a 15 percent drop in total cultivated acreage since 1996, as the acreage planted with dry beans and safflower has declined (Field Crops) (Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*).

Table 11-9. Crop Production in the SDWQ Area of Potential Effects for 2005

Crop Category & Crop	Acres
Fruits & Nuts	
Apples	18
Apricots	204
Olives	77
Peaches & Nectarines	0
Pears	0
Plums	5
Almonds	3,107
Walnuts	2,051
Pistachios	18
Fruit or Nut < 10 acres	56
Subtotal	5,536
Field Crops	
Cotton	34
Safflower	2,684
Sugar Beets	135
Corn	15,481
Grain Sorghum	0
Sudan	1,286
Castor	0
Dry Beans	4,417
Sunflowers	0
Hybrid sorghum/sudan	71
Subtotal	24,108
Grain & Hay	
Wheat & Oat	7,297
Pasture	
Alfalfa	31,342
Clover	0
Turf Farm	324
Pasture	3,148
Subtotal	34,814

Crop Category & Crop	Acres
Truck & Berry	
Asparagus	3,651
Green Beans	24
Cole	257
Carrots	197
Celery	105
Cucurbits	2,628
Onion & Garlic	165
Tomatoes	16,444
Strawberries	4
Peppers	253
Misc.	555
Subtotal	24,283
Vineyards	2,902
Idle	2,114
Total	101,054

Note: Data was adapted from Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*.

Water Supply, Irrigation, and Water Quality

Although growers have access to groundwater, it is not commonly used as a source of irrigation water. The majority of growers claim riparian or appropriative water rights and obtain their water supply through direct diversion of surface water from the Delta waterways (San Joaquin County 2009). Diversions are performed using pumps, siphons, or subirrigation. The operation of diversion pumps and siphons is dependent upon sufficient water depth and quality. When the depth of water in conveyance canals is too shallow, pumps and siphons cannot operate.

The salinity in the southern Delta is strongly influenced by the concentrations in the SJR at Vernalis. If the salinity of Delta water exceeds a crop's salinity tolerance, it cannot be used to irrigate that crop. Historically, salinity in the southern Delta has generally ranged between 0.2 dS/m and 1.2 dS/m and is suitable for irrigating a wide variety of agricultural crops (Chapter 5, *Surface Hydrology and Water Quality*). Chapter 5 and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta,* provide additional information regarding water quality and historical and existing salinity concentrations in the southern Delta.

The primary on-farm irrigation methods include surface methods, sprinklers, and drip or micro-irrigation methods (Table 11-10). For the most part, higher net value crops, such as Trees and Vines, are irrigated with pressurized systems, such as hand-moved sprinklers or micro-sprayers (Edinger-Marshall and Letey 1997). Generally crops with lower net revenue, such as Grains and Pasture, are irrigated with surface methods. There is significant subirrigation in the area, which provides irrigation water by controlling the water table. Dryland cropping is possible on some annual acreage in the SDWQ area of potential effects; however, the vast majority of the crops rely on a supply of irrigation water.

Table 11-10. Irrigation Method Types in San Joaquin County

Surface (%)	Sprinkler (%)	Drip and Micro (%)	Other (%)
36.0	14.2	36.6	13.2

Source: DWR 2010.

Soil salinity for crop lands is managed through the use of a leaching fraction, which is the portion of applied irrigation water that infiltrates past the root zone. The amount of water required for leaching is dependent on the crop being grown and the salinity of the water used for irrigation. Maintaining the leaching fraction is an important management tool in the southern Delta. Over time, the use of irrigation water and water management techniques, particularly leaching, brings soil salinity to equilibrium. In other words, salt introduced in the irrigation water is removed from the rootzone through the additional water supplied for leaching. There are 7,041 acres of saline soils in the SDWQ area of potential effects, or about 5 percent of the total acreage. Several leaching fraction studies examining salt are based on an irrigation water quality of 0.7 dS/m. Among the studies, the leaching fractions averaged between 21 and 27 percent, with a low of 11 percent and a high of 44 percent. Bean and Alfalfa, two crops with significant acreage (Table 11-9) in the SDWQ area of potential effects, have the highest sensitivity to salinity. These crops are successfully grown on lands with low infiltration rates, but maintain leaching fractions that average between 21 percent and 27 percent (Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*). Further information on soil salinity and leaching fractions within the boundary of the SDWA is provided in Appendix E.

11.3 Regulatory Background

11.3.1 State

Relevant state programs, policies, plans, or regulations related to agricultural resources are described below.

Farmland Mapping and Monitoring Program

Through the DOC, California administers the Farmland Mapping and Monitoring Program (FMMP). This program maps farmland throughout the state (California Department of Conservation 2007). The farmland categories listed under the FMMP are the basis of certain significance thresholds in the State CEQA Guidelines, discussed in Section 11.4.1, *Thresholds of Significance*. The categories are defined based on the U.S. Department of Agriculture's (USDA) land inventory and monitoring criteria and modified for California.

Prime Farmland is land with the best combination of physical and chemical characteristics for the production of crops. It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops when treated and managed in accordance with accepted farming methods. In addition, the land must have been used for irrigated agricultural production in the last 4 years to qualify as Prime Farmland. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use. Prime Farmland must meet several criteria, some of which are listed below (DOC 2013a).

(a) Water —The soils have xeric, ustic, or aridic (torric) moisture regimes in which the available water capacity is at least 4.0 inches (10 centimeters) per 40 to 60 inches (1.02 to 1.52 meters) of soil, and a developed irrigation water supply that is dependable and of adequate quality. A dependable water supply is one which is available for the production of the commonly grown crops in 8 out of 10 years.

(d) Water Table—The soils have no water table or have a water table that is maintained at a sufficient depth during the cropping season to allow cultivated crops common to the area to be grown.

(f) Flooding—Flooding of the soil (uncontrolled runoff from natural precipitation) during the growing season occurs infrequently, taking place less often than once every 2 years.

Farmland of Statewide Importance is land other than Prime Farmland that has a good combination of physical and chemical characteristics for the production of crops. It must have been used for the production of irrigated crops at some time during the two update cycles (4 years) prior to the mapping date, and it does not include publicly owned lands for which there is an adopted policy preventing agricultural use (DOC 2013b).

Unique Farmland is land that does not meet the criteria for Prime Farmland or Farmland of Statewide Importance and that has been used for the production of specific high–economic value crops at some time during the two update cycles (4 years) prior to the mapping date (DOC 2013b). This land is usually irrigated, but may include nonirrigated orchards or vineyards. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality or high yields of a specific crop when treated and managed according to current farming methods. Examples of such crops may include oranges, olives, avocados, rice, grapes, and cut flowers. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Williamson Act and Farmland Security Zone Contracts

As discussed above, the Williamson Act recognizes the importance of protecting agricultural land from premature development and provides a tax incentive for the voluntary enrollment of agricultural and open space lands in contracts between local government and landowners. (DOC 2010b; Gov. Code, § 51200 et seq.) Establishment of an agricultural preserve by a city or county is a prerequisite for a landowner to enter into Williamson Act contract, and only land located within the agricultural preserve is eligible. The city or county establishing the agricultural preserve also adopts rules that provide the standards for property eligibility, including minimum parcel sizes, and that determine the land use restrictions within the preserve. Once a landowner enters into a Williamson Act contract, the land is reassessed for tax purposes based upon the restrictions. This assures the landowner that property valuations and taxes will remain at lower stable levels notwithstanding location relative to urban or other developing areas. In exchange for the tax benefits of the program, the landowner agrees to keep the land in agricultural or open space use and in parcel sizes related to the quality of the land or existing use (Merced County 2015).

As was previously noted, the Williamson Act also provides for the establishment of Farmland Security Zone contracts. (Gov. Code, § 51296 et seq.) A Farmland Security Zone is an area created within an agricultural preserve by a board of supervisors upon the request of a landowner or group of landowners. Farmland Security Zone contracts offer landowners greater property tax reduction and have a minimum initial term of 20 years.

Central Valley Water Board Basin Plan Amendment for Control of Salt and Boron Discharges in the Lower San Joaquin River

The Central Valley Regional Water Quality Control Board (Central Valley Water Board) has adopted the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan). In 2004, it adopted a total maximum daily load (TMDL) and Basin Plan amendment that establishes a control program for salt and boron discharges into the LSJR to Vernalis (Central Valley Water Board 2004).

The Delta Protection Act and Delta Reform Act

The California legislature, through various statutes, has established a policy of recognizing, protecting, and preserving Delta resources, including agriculture, in various statutes. These statutes include the Delta Protection Act, referenced under Section 11.2.4, *Southern Delta (Farmland Conversion)* above, and the Delta Reform Act.

The Delta Protection Act created the Delta Protection Commission and required that the commission prepare and adopt a comprehensive long-term resource management plan for land uses within the primary zone of the Delta. The *Land Use and Resource Management Plan for the Primary Zone of the Delta* was prepared and adopted by the Delta Protection Commission in 1995 and revised in 2002. Regarding agriculture, the plan is required to conserve and protect the quality of renewable resources, preserve and protect agricultural viability, preserve and protect the water quality of the Delta, and protect the Delta from any development that results in a significant loss of habitat or agricultural land. This plan identifies nine general policies in support of Delta agriculture. Among these policies are prioritizing lower net revenue lands for conversion to nonagricultural uses, encouraging the acquisition of agricultural conservation easements, managing agricultural lands to maximize wildlife habitat, and supporting efforts to maintain a viable agricultural economy, such as educational programs, ag-tourism, and value-added production activities.

SB 1 passed during the Seventh Extraordinary Session of the Legislature in November 2009, declared that the two coequal goals for the state regarding the Delta are to achieve “a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem.” In addition, the coequal goals are to “be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.” (Pub. Resources Code, § 29702.) SBX7-1 also revised the membership of the Delta Protection Commission (Pub. Resources Code, § 29735) and included the Sacramento-San Joaquin Delta Reform Act of 2009. (Wat. Code, § 85000 et seq.) The Delta Reform Act established a new legal framework for Delta management, emphasizing the coequal goals as a foundation for state decisions about Delta management and creating the Delta Stewardship Council, which was required to develop and adopt a long-term and enforceable management plan for the Delta. The Delta Stewardship Council unanimously adopted the Delta Plan in 2013. The Delta Plan acknowledges that agriculture dominates the Delta landscape and that “agriculture is among the qualities that define the Delta as a place.” The Delta Plan identifies many challenges for Delta agriculture, including increasing urbanization (DSC 2013). Finally, SBX7-1 also created a new Sacramento–San Joaquin Delta Conservancy to support efforts that advance environmental protection and the economic well-being of Delta residents. (Pub. Resources Code, § 32320, et seq.)

Water Conservation Bill of 2009

The Water Conservation Bill, SB 7 (Steinberg), was also enacted during the Seventh Extraordinary Session in November 2009. SBX7-7 requires all water suppliers to increase efficiency in water use and evaluate additional practices that may conserve water. SBX7-7 requires that agricultural water suppliers providing water to 25,000 irrigated acres or more (excluding acres that receive only recycled water) measure the volume of water delivered to their customers; implement efficient water management practices; submit documentation for agricultural water measurement regulation compliance by preparing and adopting an agricultural water management plan (AWMP); and submit an aggregated farm-gate delivery report. AWMPs that were submitted in 2012 must be updated by December 31, 2015 and every 5 years thereafter.

In response to a continued drought State of Emergency, Governor Brown issued Executive Order B-29-15 on April 1, 2015, requiring agricultural water suppliers that supply water for between 10,000 and 25,000 acres of irrigated land to also develop AWMPs and to submit them to DWR by July 1, 2016. The executive order required plans to include "a detailed drought management plan and quantification of water supplies and demands in 2013, 2014, and 2015, to the extent that data is available." On, May 9, 2016 the governor issued Executive Order B-37-16, *Making Water Conservation a Way of Life*. Executive Order B-37-16 permanently requires the completion of AWMPs by water suppliers with over 10,000 acres of irrigated land. A general description of AWMPs within the LSJR area of potential effects is provided in Section 11.3.2, *Regional or Local [Regulatory Background]*.

11.3.2 Regional or Local

Regional or local programs, policies, plans, and regulations related to agricultural resources are described in this section. Although local policies, plans, and regulations are not binding on the State of California, below is a description of those that are relevant in the LSJR area of potential effects.

General Plans

Local agencies in California have primary responsibility for land use control and regulation within their areas of jurisdiction and, to a lesser extent, for areas within their spheres of influence. State planning and zoning law requires all California counties and incorporated cities to prepare, adopt, and implement a comprehensive general plan to guide the community's growth and development. A general plan may also include optional elements at the discretion of the local agency, such as an agricultural element or a recreation element. The counties and cities in the LSJR area of potential effects have general plans stipulating goals, objectives and policies associated with agricultural land, as described in this section.

Merced County

The *Agricultural Element* of the *2030 Merced County General Plan* (Merced County 2013) provides goals and policies related to the agricultural economy, preservation of agricultural lands, agricultural and urban area compatibility, agricultural research and education, and agricultural recreation.

- Goal AG-2: Ensure the long-term preservation and conservation of land used for productive agriculture, potentially-productive agricultural land, and agricultural-support facilities.

- Policy AG-2.1: Protect agriculturally-designated areas and direct urban growth away from productive agricultural lands into cities, Urban Communities, and New Towns.
- Policy AG-2.2: Protect productive agricultural areas from conversion to nonagricultural residential uses by establishing and implementing an agricultural mitigation program that matches farmland acres to be converted with farmland acres of a similar quality to be preserved at a 1:1 ratio. The plan also requires coordination with the six cities in Merced County and the Merced Local Agency Formation Commission (LAFCo), consistent with LAFCo's statutory mission to preserve agricultural land and open space, to establish consistent standards and mitigation for the loss of farmland. In addition, the Land Evaluation and Site Assessment Model (LESA Model) may be used to determine whether the conservation land is of equal or greater value than the land being converted.
- Policy AG-2.17: Where requested by the water purveyor, when agricultural parcels are subdivided and the original parcel (prior to subdivision) has access to surface water (such as from an irrigation or water district facility), it is required that an easement be provided over the parcel(s) that has/have access to the surface water source to the remaining parcel(s) that will not be adjacent to or near the surface water source. The easement should specify the purpose of the easement and whose responsibility it is to maintain private water conveyance facilities within said easement.

San Joaquin County

The *Resources* chapter of the *San Joaquin County General Plan* (San Joaquin County 2010) describes policies for the protection of the county's natural resources, including agricultural lands. San Joaquin County is in the process of updating its general plan.

- Objective 1: To protect agricultural lands needed for the continuation of commercial agricultural enterprises, small-scale farming operations and the preservation of open space.
- Objective 3: To minimize the impact on agriculture in the transition of agricultural areas to urban development.
- Policy 5: Agricultural areas shall be used principally for crop production, ranching, and grazing.
- Policy 6: All lands designated for agricultural uses and those lands designated for nonagricultural use but not needed for development for 10 years shall be placed in an agricultural preserve and shall be eligible for Williamson Act contracts. Parcels eligible for Williamson Act contracts shall be 20 or more acres in size in the case of prime land, or 40 or more acres in the case of non-prime land.

Stanislaus County

The *Agricultural Element* of the *Stanislaus County General Plan* (Stanislaus County 2012) describes goals, objectives, policies, and implementation measures focused on the protection of the economy of the county by minimizing conflicts between the environment, agriculture, and urban development. Stanislaus County is currently updating its general plan and incorporating a 20-year planning horizon to 2035.

- Goal 1: Strengthen the agricultural sector of the economy.
- Goal 2: Conserve our agricultural lands for agricultural uses.

- Policy 1: Established agricultural land use categories that promote a range of agricultural activities and preserve open space (e.g., general agriculture, limited agriculture, and agriculture-urban reserve).

City of Tracy

The *City of Tracy General Plan's Open Space and Conservation Element* contains an objective (OSC-2.2) and policy (P1) focused on minimizing conflicts between agricultural and urban uses, and the policy establishes buffer zones around development projects to protect agriculture operations from the impacts of incompatible development (City of Tracy 2011).

City of Stockton

The *Land Use Element* of the *2035 Stockton General Plan Goals and Policies Report* discusses the City's goal to promote the protection of agricultural lands outside of the urban service area and to discourage the premature conversion of agricultural lands within the urban service area. Related policies limit urban uses in agricultural land and establish permanent agricultural/open space buffers along the "ultimate edge" of the Urban Service Area (Policies LU-2.1 and LU-2.2, respectively). In addition, The *Natural and Cultural Resources Element* describes the goal and related policies to foster a viable agricultural industry in the city through promoting the continuation of existing agricultural operations; insuring the compatibility of Stockton's Right to Farm ordinance with San Joaquin County's ordinance; supporting an Agricultural Conservation Program; and supporting policies adopted by San Joaquin County to promote agricultural viability (City of Stockton 2007).

City of Modesto

The *Environmental Resources and Open Spaces* element of the City of Modesto's *Final Urban Area General Plan* identifies agricultural resources policies focused on minimizing the loss of agricultural land by maintaining future development such that it is relatively compact and of "reasonable high density." Where necessary to promote planned growth, the City encourages the development of agricultural lands that are already compromised by adjacent urban development (City of Modesto 2008).

City of Merced

Agriculture is a major contributor to the economic viability of the City of Merced. As such, Merced's general plan identifies goals and policies intended to foster the protection of agriculture and the preservation of agriculturally significant areas by directing development away from significant concentrations of Prime agricultural soils, giving priority to the conversion of non-prime agricultural land, and limiting development impacts on agricultural lands along the city's urban fringe (City of Merced 2015).

City of Turlock

In its general plan, the City of Turlock states that one of the eight "General Plan Themes" is the establishment of limits to urban growth to maintain Turlock as a "freestanding city surrounded by agricultural land" (City of Turlock 2012). To that end, policies related to agricultural resources in the *Turlock General Plan* promote continued agricultural activity on lands surrounding the urban areas of the city; encourage infill to protect farmland; minimize conflict between urban and agricultural uses; require participation in county-wide agricultural mitigation; and support participation in the Williamson Act Program (City of Turlock 2012).

City of Riverbank

The *Conservation and Open Space* element of the *City of Riverbank General Plan 2005–2025* addresses the importance of agriculture in the city of Riverbank through policies that focus on sustaining agriculture and resources associated with farming. These policies include developing a sustainable agricultural strategy to conserve agricultural production in the Stanislaus River Watershed and establishing buffers to protecting ongoing agricultural practices in the western portion of the Riverbank planning area from urban encroachment (City of Riverbank 2009).

City of Oakdale

The *Land Use* and *Natural Resources* elements of the *City of Oakdale 2030 General Plan* identify goals and policies related to the preservation of agricultural lands and agricultural operations within and outside of the City of Oakdale's planning area. Policies include supporting the production of existing agricultural properties; preparing and adopting a plan for agricultural preservation; and maintaining agricultural and rural lands outside of urbanized areas (City of Oakdale 2013).

City of Ripon

The *Open Space and Conservation* element of the *City of Ripon General Plan 2040* establishes goals and policies to protect recreational, cultural, and natural resources, including agricultural resources. The general plan identifies policies intended to discourage premature conversion of agricultural lands, reduce the intrusion of urban development in agricultural areas, and prohibit the conversion of agricultural land to urban uses unless the property is contiguous to existing or approved urban uses (City of Ripon 2006).

City of Manteca

The *Resource Conservation Element* of the *City of Manteca General Plan 2023 Policy Document* outlines a goal and related policies to "promote the continuation of agricultural uses in the Manteca area and discourage the premature conversion of agricultural land to nonagricultural uses, while providing for the urban development needs of Manteca" (City of Manteca 2011).

City of Lathrop

The *Comprehensive General Plan for the City of Lathrop* (City of Lathrop 2004) stresses the importance of minimizing the amount of agricultural land converted for urban use and avoiding premature conversion of agricultural land. Agricultural land policies are focused on avoiding urban-agricultural conflicts at the margin of urban areas.

City of Escalon

Select goals and policies identified in the *Urban Boundary Element* and the *Open Space, Conservation and Recreation Element* of the City of Escalon's general plan stress the need to preserve and protect agricultural use on lands in and around the Escalon planning area for open space, and to prohibit the premature conversion of agricultural lands where agricultural preserves are present (City of Escalon 2010).

Zoning

The general plan for counties and cities is commonly implemented through zoning and other local land use and development ordinances that must be consistent with the general plan. City and county zoning ordinances in the LSJR area of potential effects generally allow a variety of agricultural and related uses. In reviewing and making decisions on applications for various land use entitlements and development projects, the local agency must typically make findings that the proposed activity (e.g., a conditional use permit or a subdivision of real property) is consistent with the applicable general plan. If the decision is discretionary and a project could have a potentially significant adverse effect on the physical environment, then the county or city is also obligated to comply with the procedural and documentation requirements of CEQA. Table 11-11 identifies the approximate acres zoned for agriculture or related use (e.g., agricultural residential) in the LSJR area of potential effects according to the six geographic areas, as well as in the SDWQ area of potential effects.

Table 11-11. Acreages Zoned for Agricultural Use in the LSJR and SDWQ Areas of Potential Effects

Areas of Potential Effects	Zoned Agricultural Land [a, b]
LSJR Area of Potential Effects	
SEWD/ CSJWCD	119,000
SSJID	55,000
OID	65,000
TID	161,000
MID	69,000
Merced ID	129,000
Total	598,000 [c]
SDWQ Area of Potential Effects	
Total	113,000 [d]

LSJR	= Lower San Joaquin River
SDWQ	= southern Delta water quality
SEWD	= Stockton East Water District
CSJWCD	= Central San Joaquin Water Conservation District
SSJID	= South San Joaquin Irrigation District
OID	= Oakdale Irrigation District
MID	= Modesto Irrigation District
TID	= Turlock Irrigation District
Merced ID	= Merced Irrigation District

[a] Acreage values are rounded to the nearest thousand and are based on available GIS zoning data for the cities and counties within the areas of potential effects.

[b] *Zoned agricultural land* includes land designations made by the applicable local jurisdictions (i.e., Merced, Stanislaus, and San Joaquin Counties) that are intended to protect farmland and farming activities from incompatible uses.

[c] Approximately 73,000 additional acres lie within the LSJR area of potential effects that could not be identified according to county or city zoning because GIS zoning data was not available.

[d] Approximately 4,000 additional acres lie within the SDWQ area of potential effects that could not be identified according to county or city zoning because GIS zoning data was not available.

Agricultural Water Management Plans or Water Management Plans

Pursuant to the Water Conservation Bill of 2009 (SBX7-7), OID, Merced ID, MID, SSJID, SEWD, and TID have prepared AWMPs. Table 13-10 in Chapter 13, *Service Providers*, describes methods that are common throughout all of the irrigation district AWMPs for addressing surface water shortages. Below is a brief summary of information contained in each district's AWMP regarding water shortage allocation polices and water management.

Oakdale Irrigation District

OID supplies irrigation water and domestic drinking water for subdivisions outside of the City of Oakdale service area.[7] The district's primary water supply comes from surface water diversions on the Stanislaus River at Goodwin Dam. OID's surface water shortage policy "includes suspension of surface water deliveries once available supplies are exhausted, but allows for intra-district water transfers and the use of available groundwater from OID wells" (OID 2012). OID's *Rules and Regulations Governing the Operation and Distribution of Irrigation Water within the Oakdale Irrigation District Service Area* (Rules and Regulations) are occasionally reviewed and revised as needed to address changing conditions and to account for dry periods, most recently in 2005. The rules and regulations prescribe conditions that ensure distribution of irrigation water to users in an orderly, efficient and equitable manner. Depending on the severity of the water shortage the district may suspend out of district agreements, provide irrigation water for agricultural purposes only, and implement a zero discharge policy, with fines for violators. OID's AWMP identifies implemented and planned efficient water management practices (EWMPs), including providing technical assistance for growers implementing on-farm improvements through the Natural Resources Conservation Service Environmental Quality Incentives program; continuing a testing and evaluation program for existing pumps; and implementing OID's water resources plan flow control and measurement structure projects (OID 2012).

Merced Irrigation District

The Merced River is the main source of Merced ID's water supply. During an average wet year, 99 percent of Merced ID's water supply comes from surface water. The remainder of the supply comes from groundwater. Merced ID identifies a conjunctive water management strategy in their AWMP as part of its drought water management approach. This strategy is intended to manage groundwater conditions so that during surface water supply shortages, there will be sufficient water supplies available to meet the district's needs. Furthermore, during years of surface water shortage, Merced ID reduces the allocation to its growers proportioned to its Class I and Class II users. The Merced ID AWMP identifies several EWMPs, such as facilitating financial assistance to support on-farm improvements needed to take surface water from Merced ID during years of available surface water and utilize groundwater wells during years of surface water shortages. Other Merced ID EWMPs include implementing an incentive pricing structure to encourage more efficient water use at the farm level; constructing/operating tailwater and spill recovery systems; and promoting and performing pump testing (Merced ID 2013).

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[7] OID surface water is provided for agriculture, and OID owns and operates a rural water system that provides groundwater for domestic use.

Modesto Irrigation District

MID supplies groundwater and surface water from the Tuolumne River to agricultural, residential, and municipal customers. Tuolumne River water supplies vary depending on precipitation, snow melt runoff, and the previous year's carryover storage in Don Pedro Reservoir. During dry years, the MID Board of Directors reduces water allocation and may shorten the irrigation season. In addition, MID will also conjunctively use groundwater to supplement surface water and water users may use private irrigation wells to supplement water supplied by the irrigation district. MID has an irrigation water allocation policy, which establishes the allocation and cost of water to landowners. It is adopted by the Board of Directors annually. The allocation is based on factors including the volume of water carried over in storage in Don Pedro Reservoir and the projected runoff from the watershed. The allocation is not finalized and adopted until after the rainy season when runoff information has been made available. Identified in MID's AWMP are several ongoing and planned EWMPs, such as facilitating alternative land uses for lands with high water duties or irrigation problems, including drainage issues; providing financial assistance to water users to replace private ditches and pipelines; and lining approximately 86 percent of the district's delivery canals with concrete (MID 2012).

South San Joaquin Irrigation District

SSJID diverts water from the Stanislaus River at Goodwin Dam into the Joint Main Canal, which is jointly owned and operated by SSJID and OID, with 72 percent of the capacity intended for SSJID. SSJID provides water predominately for irrigation, but also provides treated surface water to the cities of Manteca, Lathrop, and Tracy for domestic use (SSJID 2012). SSJID's surface water shortage contingency actions entail eight operational measures including postponing the start date of the irrigation season; implementing a variable water delivery rotation schedule and maximum time limits for flood irrigation; allowing for inter-parcel transfers/fallowing; and implementing irrigation quantity limits for pressurized systems (SSJID 2012). The SSJID AWMP identifies several ongoing EWMPs and the activities implemented and planned to achieve those EWMPs. Some planned activities include continuing their On-Farm Conservation Program, which provides financial incentives to improve the existing distribution system and enhance farm irrigation practices (SSJID 2013); refining conjunctive management by further evaluating the underlying groundwater system; and continuing and expanding spill site monitoring to reduce spillage and develop representative data (SSJID 2012). SSJID functions in an economical manner to distribute the water equitably and in as satisfactory a manner as possible for all water users.as near as may be satisfactory to all water users. No two individuals have exactly the same requirements, and while these individual requirements will be met as far as possible, there must be general rules and general practices to secure the greatest good to the greatest number.

Stockton East Water District

SEWD serves both urban and agricultural water users. SEWD receives surface water from both the Stanislaus River (within the LSJR area of potential effects) and Calaveras River (outside of the LSJR area of potential effects). SEWD also has a contract to provide water to CSJWCD (within the LSJR area of potential effects) on an annual basis (SEWD 2014). The *Stockton East Water Management Plan* (SEWD 2014) includes information that addresses the AWMP requirements, including the agricultural water allocation policy, as well as an EWMP report and best management practices (BMPs) for agricultural contractors. According to the agricultural water allocation policy, SEWD has sufficient water to withstand 2 to 3 dry years. When a water year has been identified as a dry year, SEWD requests voluntary water use reductions from its agricultural customers. In a subsequent dry year, these voluntary reductions are identified as critical, and in a third subsequent dry year, these reductions may be mandatory (SEWD 2014). In all water years, SEWD customers are asked to call in advance of diverting water so that the district may adjust water releases; this advance notice is mandatory in dry years. SEWD's water management plan identifies several BMPs that the district implements in the context of efficient water management, such as providing evaluation of irrigation practices to its customers; implementing agricultural water management educational programs for farmers and the public; and optimizing conjunctive management of surface and groundwater (SEWD 2014).

Turlock Irrigation District

TID receives its principal water supply from the Tuolumne River. TID supplements surface water releases with drainage wells and rented wells, and also uses supplemental groundwater pumping to help conserve water by reducing canal spillage. TID primarily supplies irrigation water for agriculture in its service area, but also provides drinking water to the community of La Grange, in conjunction with MID. TID's surface water shortage policies include increasing groundwater pumping, implementing a "dry year" rate schedule, and internal transfers (TID 2012). Historically a three-tiered, increasing block rate schedule based on three classes of water deliveries has been used. The first block is the annual allotment that was available equally to each acre of land. The volume of the allotment varied depending upon the available surface water supply. The actual allotment, as well as any additional water available above the allotment, is set each year based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps. TID's AWMP also identifies currently implemented and planned EWMPs, such as operating spill and tailwater recovery systems; facilitating the use of available recycled water; implementing a pricing structure that promotes various goals to improve water use efficiency; and converting 90 percent of its conveyance and distribution system to pipeline or concrete lined canals (TID 2012).

11.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on agricultural resources. It further describes the methods of analysis used to determine significance. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

11.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Agricultural resource impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis as to whether the alternatives could result in the following.

- Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland) to nonagricultural use.
- Involve other changes in the environment which, due to their location or nature, could result in conversion of farmland to nonagricultural use.
- Conflict with existing zoning for agricultural use or a Williamson Act contract.
- Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect.

Where appropriate, specific quantitative or qualitative criteria are described in Section 11.4.2, *Methods and Approach*, for evaluating these thresholds.

As described in Appendix B, *State Water Board's Environmental Checklist*, the alternatives would result in either no impact or less-than-significant impacts with regards to the following conditions, and therefore are not discussed further in this chapter.

- Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Pub. Resources Code, § 12220(g)), timberland (as defined by Pub. Resources Code, § 4526), or timberland zoned Timberland Production (as defined by Gov. Code, § 51104(g).)
- Result in the loss of forest land or conversion of forest land to nonforest use.

11.4.2 Methods and Approach

Under the LSJR and SDWQ alternatives, two basic changes could result in significant impacts on agricultural resources: reduction in surface water diversions for crop production in the LSJR area of potential effects or a change in water quality that could result in crop yield reductions in the SWDA. Both of these changes have the potential to affect crop production and lead to conversion of irrigated lands to nonagricultural uses in either the LSJR area of potential effects or the SDWQ area of potential effects.

The methods for analyzing impacts under the LSJR and SDWQ alternatives are described below.

LSJR Alternatives

This chapter evaluates the potential groundwater impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and different methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. The sections below describe steps for processing the WSE model results for the groundwater analysis, methods of analysis for adaptive implementation in this chapter, and baseline results to which the LSJR alternatives are compared to determine the significance of impacts on groundwater. The LSJR alternatives could result in a reduction of surface water diversions currently used to irrigate existing agricultural lands. The WSE and SWAP models are the primary tools used to assess how decreased surface water supplies under the LSJR alternatives could impact irrigated crop land.

Four separate models were used to analyze agricultural impacts. Brief definitions of each model and the manner in which they are used and applied to the analysis are given below. For full descriptions of the models refer to the appendices listed by each model below.

- Water Supply Effects (WSE) Model – Appendix F.1, *Hydrologic and Water Quality Modeling*.
- Statewide Agricultural Production (SWAP) Model – Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results.*
- Impact Analysis for Planning (IMPLAN) – Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results.*
- Salinity Related Impacts – Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta.*

Water Supply Effects Model

Results from the WSE model were used in the SWAP model to generate annual crop production under each LSJR alternative. The WSE model generated monthly surface water diversion volumes and estimated the availability of water delivery for crop production expected under each LSJR alternative. In addition to surface water, groundwater was assumed to be available (see Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* and Chapter 9, *Groundwater Resources,* for more information regarding groundwater) and was included in the monthly water amounts available for irrigation. Monthly surface and groundwater values were aggregated to cropping season requirements. Annual crop production under each LSJR alternative is represented as acreage of a given crop category by year for 1922–2003.

Estimates of the total amount of water applied to the irrigated lands of the irrigation districts (applied water) are required for the SWAP analysis. Applied water rates are unique to each crop category and to each geographic area. Applied water demands may be satisfied by surface water and groundwater, or a combination of the two. After the water is applied to the irrigated land, it will either be consumptively used by the crops, return to the river as surface runoff, or percolate into the ground below the fields. However, for the WSE modeling surface runoff from the fields is accounted for separately from applied water, as part of the "spills and returns" of each irrigation district. For more information on applied water see Appendix G, Section G.4.2, *Crop Distribution and Applied Water Inputs for SWAP*.

Some post-processing of the WSE model results is required to generate the applied water input for the SWAP analysis. As part of post-processing, the diversions for each river are partitioned between different types of deliveries and losses. Volumes of water assumed not to be subject to a water shortage (e.g., municipal and industrial water supply, riparian rights) are subtracted from the total diversions for each river to calculate the remaining water. Any water left over is then delivered to the irrigation districts to be used for applied water demands and to account for the operational spills and river returns from the district. In the modeling, operational spills and river returns are assumed to be fully accounted for, even in times of water shortage. In addition, some fraction of the water delivered to the districts will also be lost as seepage or evaporation from the conveyance system. When diversions are less than what is needed to meet full demands (including all categories of deliveries and losses), only the applied water deliveries are assumed to be reduced (which, in turn, will also reduce the conveyance losses). This allows for a conservative estimate of agricultural impacts (i.e., agricultural impacts may be slightly overestimated rather than underestimated).

In the WSE model, SEWD and CSJWCD diversions from the Stanislaus River are calculated separately from the SSJID and OID diversions because they are CVP contractors and only receive water after SSJID and OID water rights have been met. The division of Stanislaus River water between SSJID and OID and Tuolumne River water between MID and TID is calculated as part of post processing. This is based on the assumption that each district receives the same percent of surface water demand for consumptive use, as described in Appendix G.

The capacity of each irrigation district to pump groundwater varies and depends on existing infrastructure (Chapter 9, *Groundwater Resources*, Table 9-6, and Appendix G). Within the districts, there is a minimum amount of groundwater pumping that occurs every year. If the amount of available surface water and minimum groundwater pumping is insufficient to meet the irrigation district's applied water demands, then additional groundwater pumping would occur. In this situation, groundwater pumping would increase either to meet the shortage or until it reaches the maximum amount that the districts could pump. The maximum groundwater pumping capacities are estimated based on best available data as described in Chapter 9 and Appendix G. Agriculture is potentially affected when the additional groundwater pumping is unable to fully meet the shortfall in the applied surface water.

Because baseline is representative of 2009 groundwater infrastructure, the primary agricultural analysis utilizes estimates of maximum groundwater pumping that were possible in 2009. However, as a result of recent drought conditions, more wells have been drilled and, therefore, an assessment using estimates of maximum groundwater pumping for 2014 is also discussed in Section 11.4.3, *Impacts and Mitigation Measures*. All of the 2014 maximum groundwater pumping estimates are greater than the 2009 maximum groundwater estimates, with the exception of Merced ID, for which the two estimates are the same. This is reasonable because Merced ID's 2009 capacity for increased groundwater pumping was almost sufficient to meet full demand in drought years.

Adaptive Implementation

Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, which would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.
4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cubic feet per second (cfs) may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water.

The quantitative results included in the figures, tables, and text of this chapter present WSE modeling results of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). However, the modeling does allow some inflows to be retained in the reservoirs after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects and this is included in the results presented in this chapter. If the percent of unimpaired flow is not specified in this chapter, these are the percentages of unimpaired flow evaluated in the impact analysis. However, as part of adaptive implementation method 1, the required percent of unimpaired flow could change by up to 10 percent if the STM Working Group agrees to adjust it. The highest possible percent of unimpaired flow associated with an LSJR alternative is also evaluated in the impact analysis if long-term implementation of method 1 has the potential to affect a determination of significance. For example, if the determination for LSJR Alternative 2 at 20 percent unimpaired flow is less than significant, but the determination for LSJR Alternative 3 at 40 percent unimpaired flow is significant, then LSJR Alternative 2 is also evaluated at the 30 percent unimpaired flow. This use of modeling provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

SWAP Model

After the post processing of the WSE model results, as described above, the SWAP model simulates the decisions of growers at a regional level based on the principles of economic optimization. The model assumes that farmers maximize profit subject to resources and market constraints, shifting crop production to favor crop categories that maximize profit subject to given constraints. The model accounts for land and water availability and production prices, while calibrating to observed yearly values of land, labor, and water supplies. The basic model outputs are annual estimates of crop production acreage, water use, and revenue by the 19 crop categories in the DAU survey (Table 11-4) for the LSJR alternatives.

Impact AG-1 uses the quantitative results of the SWAP model to first evaluate if significant reductions in agricultural acreage or significant reductions in crop mix would occur under the LSJR alternatives. This analysis uses cumulative distribution tables since the cumulative distribution of a particular variable (e.g., irrigated acreage) provides a basic summary of the distribution of values. The percentile (percent cumulative distribution) associated with each value indicates the percent of time that the values were less than the specified value. For example, as depicted in Figure 11-3b, for SSJID under baseline conditions, approximately 1,656 acres of Pasture receive irrigation water at the 80th percentile, while approximately 473 acres of Pasture are irrigated at the 90th percentile; and, in all water years (i.e., 100th percentile) there is sufficient supply to irrigate only about 50 acres of Pasture. In other words, the acreage value at the 100th percentile provides an estimate of irrigated acreage that is likely to be exceeded 100 percent of the time, meaning that this fraction of irrigated pasture under baseline conditions would be expected to always be irrigated in SSJID, even under the driest possible conditions. The acreage value at the 0 percentile is an amount of irrigated acreage that would never likely be exceeded, even under the wettest conditions.

The amount of irrigated acreage is central to the analysis of Impact AG-1 because, by definition, Prime Farmland and Farmland of Statewide Importance, as described by the 2006 FMMP, requires a dependable water supply in 8 out of 10 years (DOC 2007). Stated another way, if there is more than a 20 percent reduction in overall irrigated acreage, then the water supply for that crop will be assumed to be inadequate to maintain the Prime Farmland and Farmland of Statewide Importance criteria. For this analysis, annual changes in the amount of irrigated acreage over the 82-year modeling period were averaged by irrigation district,.

The SWAP-generated baseline was the basis for comparison and determination of potential impacts on irrigated cropland for Impact AG-1. However, the SWAP model cannot quantify whether actual conversation of Prime, Farmland of Statewide Importance, and Unique Farmland to nonagricultural uses would result, given numerous factors, including the individual decisions of agricultural producers that influence potential conversion. However, as the amount of irrigated lands that are converted to non-irrigated agriculture increases, the likelihood that *some* of these lands may result in being converted to nonagricultural uses, including urbanization, would be expected to increase.

The 2013 California Water Plan Update for the San Joaquin River Hydrologic Region (DWR 2014) projects that by 2050 urbanization will result in the permanent conversion of between 6 percent and 14 percent of irrigated acreage in the San Joaquin Valley annually. This conversion is dependent on many development pressure factors, such as population growth and the density of development of surrounding lands. Although predicting which irrigation districts would be more likely to be affected by urbanization in the San Joaquin Valley is not possible because it would depend on local land use decisions, a reduction of irrigated lands would be expected to influence where conversions occur. For example, all the irrigation districts presently contain urban and built-up lands, much of it along the Highway 99 corridor, and most conversions of agricultural lands to urban uses happen in the urban fringe area. Therefore, it is reasonable to assume that the amount of land that may actually convert to nonagricultural use in the San Joaquin Valley would include some fraction of the percentage of land that does not receive irrigation in the LSJR area of potential effects for agricultural resources. It is also reasonable to assume that some percentage of the farmland that would be converted to nonagricultural uses has been included as part of recent projections (6–14 percent annually) for urban conversion (although reductions in the availability of irrigation water may have more influence on the ultimate location of development as opposed to the extent of development). Importantly, a presumably large proportion of the farm lands affected by potential reductions of irrigation water supply, as estimated by the SWAP model, is likely to remain either temporarily or permanently in nonirrigated agricultural use (e.g., dryland farming, grazing, and fallowing). Based on consideration of these factors, a predicted reduction of 4 percent or more of irrigated acreage in any one district was adopted as a conservative threshold for determining significance for Impact AG-1.

For Impact AG-2, other changes in the existing environment, as possibly predicted by the SWAP model, are addressed, including seepage effects on agricultural lands and indirect effects of reduced Pasture and Alfalfa on dairies. Information from Chapter 5, *Surface Hydrology and Water Quality*, and Chapter 6, *Flooding, Sediment, and Erosion,* is incorporated to identify Stanislaus River flow levels that may result in elevated seepage in areas previously identified as being affected by Stanislaus River flows. Information from the SWAP model and irrigation district water use are used to qualitatively discuss indirect effects on dairies. To observe impacts that may affect the dairy industry acreage for Alfalfa and Pasture or Corn and Grain from the SWAP model can be combined. The SWAP model has limitations in modeling performance of feed crops as these crop groups usually have lower net returns to land and management. The issue is overcome for dairies by employing minimum silage constraints as silage typically must be produced closed to the dairies. Given the SWAP model uses a simplified assumption that water use would shift from lower net revenue crops to high-value crops, it likely over predicts the shift for other feed crops.

Impacts AG-3 and AG-4 were qualitatively evaluated based on whether the reduced crop production conflict with Williamson Act or zoning policies. The evaluation incorporates the existing setting information identified in Sections 11.2.2, *Lower San Joaquin River Watershed and Eastside Tributaries*, and 11.3, *Regulatory Background*, and the authority of the State Water Board as a state agency under each of the LSJR alternatives.

SWAP Modeled Baseline

Based on the WSE model estimates of allowable surface water diversions and available groundwater for the 1922–2003 period, SWAP model output show the distribution of crop acreage by crop categories for each irrigation district in the area of potential effects (Table 11-12 and Figures 11-3a and 11-3b through Figure 11-8). Crop category groupings are based on similar type crops. These combinations were selected because of similar net revenue by crop category, the ability to observe impacts on specific industries such as dairy and cattle, and where appropriate to reduce the overall number of impact curves. These figures provide examples of how the acreage of different crop types can change in response to water availability. Figure 11-3, for example, shows that the acreage of permanent crops (Almonds, Orchards, Pistachio, Subtropical, and Vine) changes very little. There is only a very small reduction that occurs in less than 10 percent of years, when acreage drops from approximately 41,000 acre to approximately 39,000 acres. The acreage of pasture stays the same, about 2,300 acres, most of the time under baseline. However, unlike for permanent crops, acreage decreases in about 15 percent of years to acreages approaching zero under baseline. This is generally reflective of the response of irrigated agriculture to reduced water availability—limited water supplies are typically directed towards permanent crops and crops with higher net revenue.

Salinity Impacts of LSJR Alternatives

The effects of the LSJR Alternatives on salinity concentrations in the SJR at Vernalis and the southern Delta are evaluated using the WSE model as presented in Appendix F.1, *Hydrologic and Water Quality Modeling*. The impacts of these salinity concentrations relative to baseline are analyzed in Chapter 5, *Surface Hydrology and Water Quality* (Impacts WQ-1 and WQ-2) and determined to be less than significant for all LSJR alternatives. Therefore, the associated salinity impacts on agricultural resources are also considered to be less than significant and are not discussed further in this chapter.

Table 11-12. Average Annual SWAP Baseline Acreage and Percent by Crop Category for Each Irrigation District

	SSJID		OID		SEWD & CSJWCD		MID		TID		Merced ID	
	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total
Alfalfa	3,080	5.3	2,098	3.9	6,870	6.9	2,513	4.4	13,115	9.1	5,634	5.6
Almonds and Pistachios	27,022	46.4	10,519	19.4	17	0.0	13,139	22.9	33,741	23.5	30,616	30.7
Corn	8,248	14.2	9,810	18.1	16,096	16.3	10,506	18.3	43,283	30.1	19,109	19.2
Cotton	NC		NC		NC		NC		NC		2,482	2.5
Cucurbits	486	0.8	103	0.2	818	0.8	128	0.2	469	0.3	649	0.7
Dry Bean	172	0.3	216	0.4	768	0.8	254	0.4	1,065	0.7	NC	
Grain	1,666	2.9	387	0.7	8,320	8.4	215	0.4	460	0.3	3,177	3.2
Onion and Garlic	602	1.0	NC		179	0.2	NC		NC		NC	
Orchards	6,847	11.8	6,508	12.0	43,174	43.6	8,138	14.2	8,221	5.7	4,884	4.9
Other Field Crops	203	0.3	7,865	14.5	NC		9,376	16.3	28,848	20.1	7,145	7.2
Other Truck Crops	431	0.7	2,854	5.3	1,119	1.1	3,548	6.2	8,020	5.6	11,912	11.9
Pasture	1,582	2.7	8,597	15.9	4,019	4.1	7,754	13.5	4,106	2.9	5,622	5.6
Rice	82	0.1	4,188	7.7	NC		639	1.1	NC		1,158	1.2
Safflower	158	0.3	NC		NC		NC		NC		NC	
Subtropical	1,743	3.0	137	0.3	NC		42	0.1	63	0.0	NC	
Sugarbeet	NC		NC		NC		NC		NC		277	0.3
Tomato (Fresh)	70	0.1	NC		8,064	8.2	NC		379	0.3	1,847	1.9
Tomato (Processing)	446	0.8	NC		NC		NC		NC		1,383	1.4
Vine	5,391	9.3	881	1.6	9,487	9.6	1,103	1.9	2,014	1.4	3,874	3.9
Total	58,229		54,162		98,931		57,354		143,783		99,769	

SEWD/CSJWCD = Stockton East Water District/Central San Joaquin Water Conservation District

SSJID = South San Joaquin Irrigation District

OID = Oakdale Irrigation District

MID = Modesto Irrigation District

TID = Turlock Irrigation District

Merced ID = Merced Irrigation District

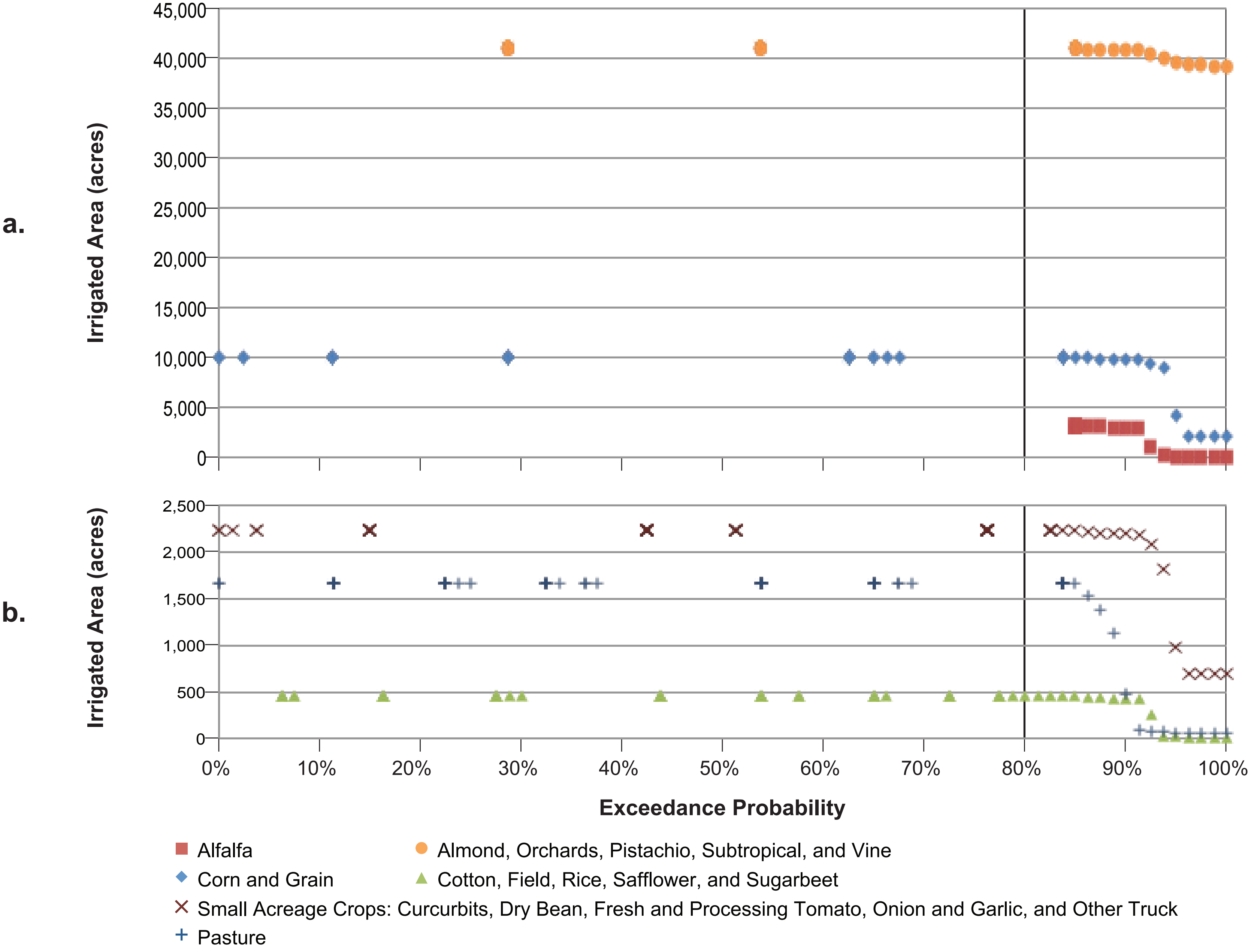

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Figure 11-3
Irrigated Acreage in SSJID for Baseline

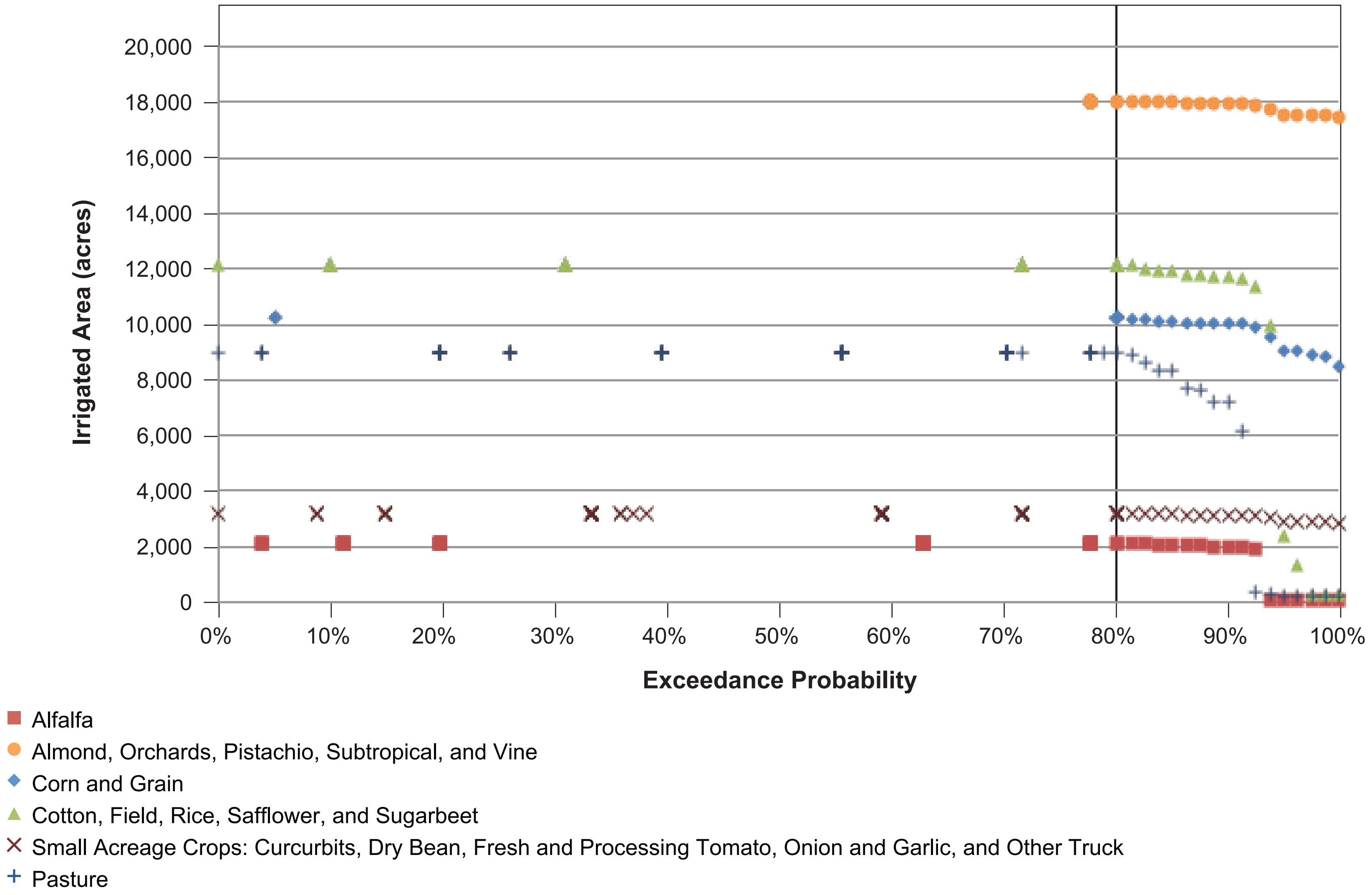

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Figure 11-4
Irrigated Acreage in OID for Baseline

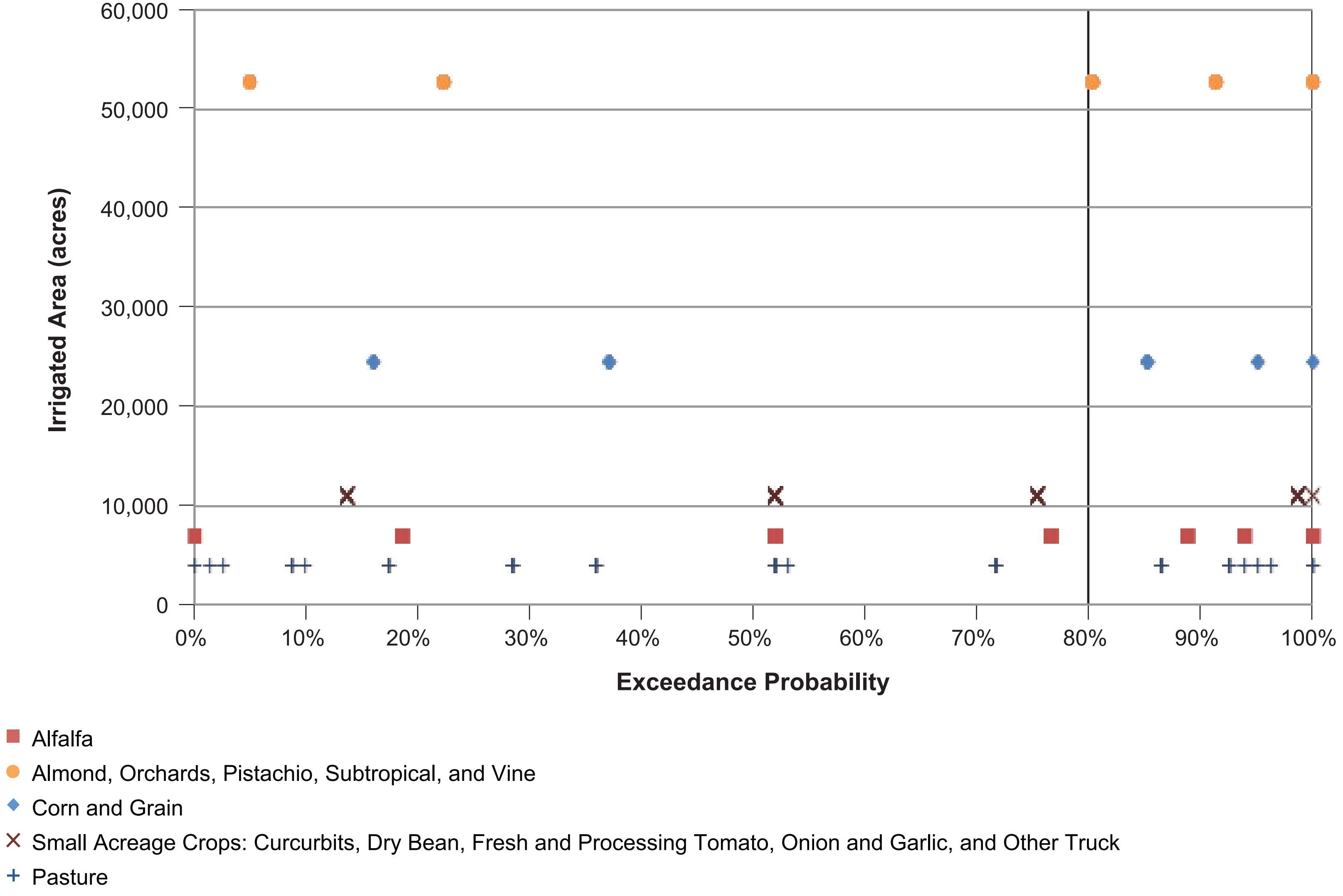

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Figure 11-5

Irrigated Acreage in SEWD and CSJWCD for Baseline

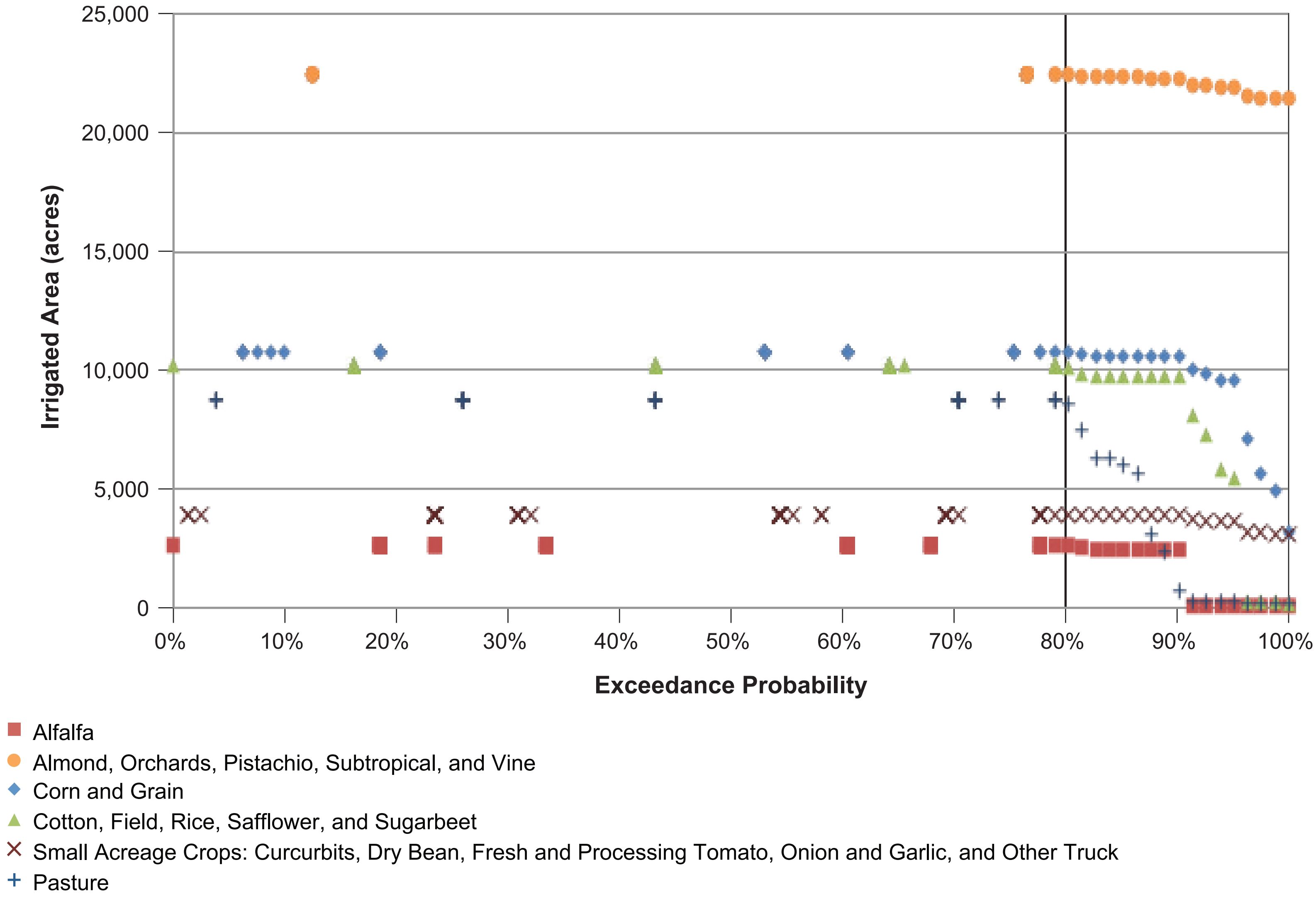

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Figure 11-6
Irrigated Acreage in MID for Baseline

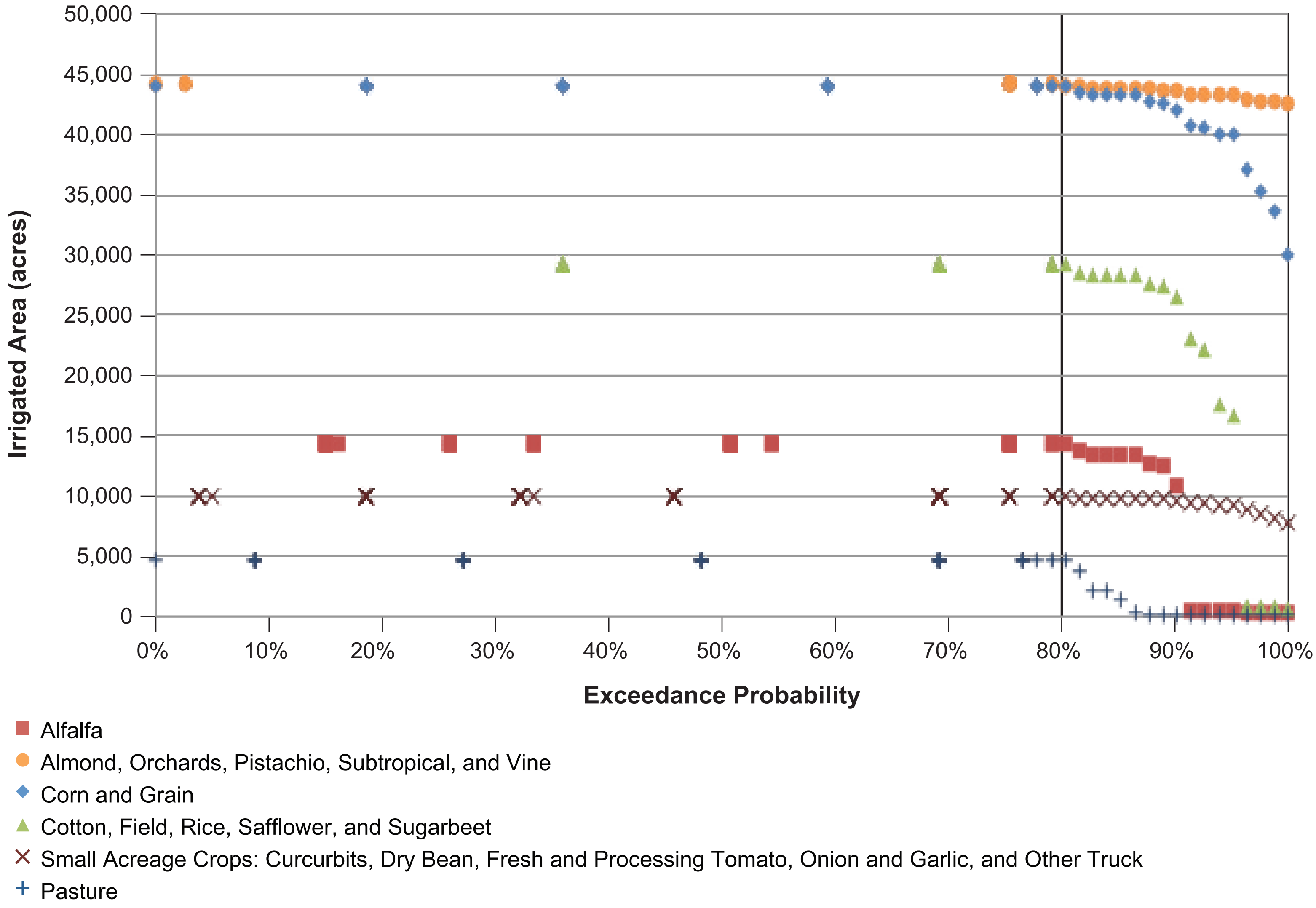

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Figure 11-7
Irrigated Acreage in TID for Baseline

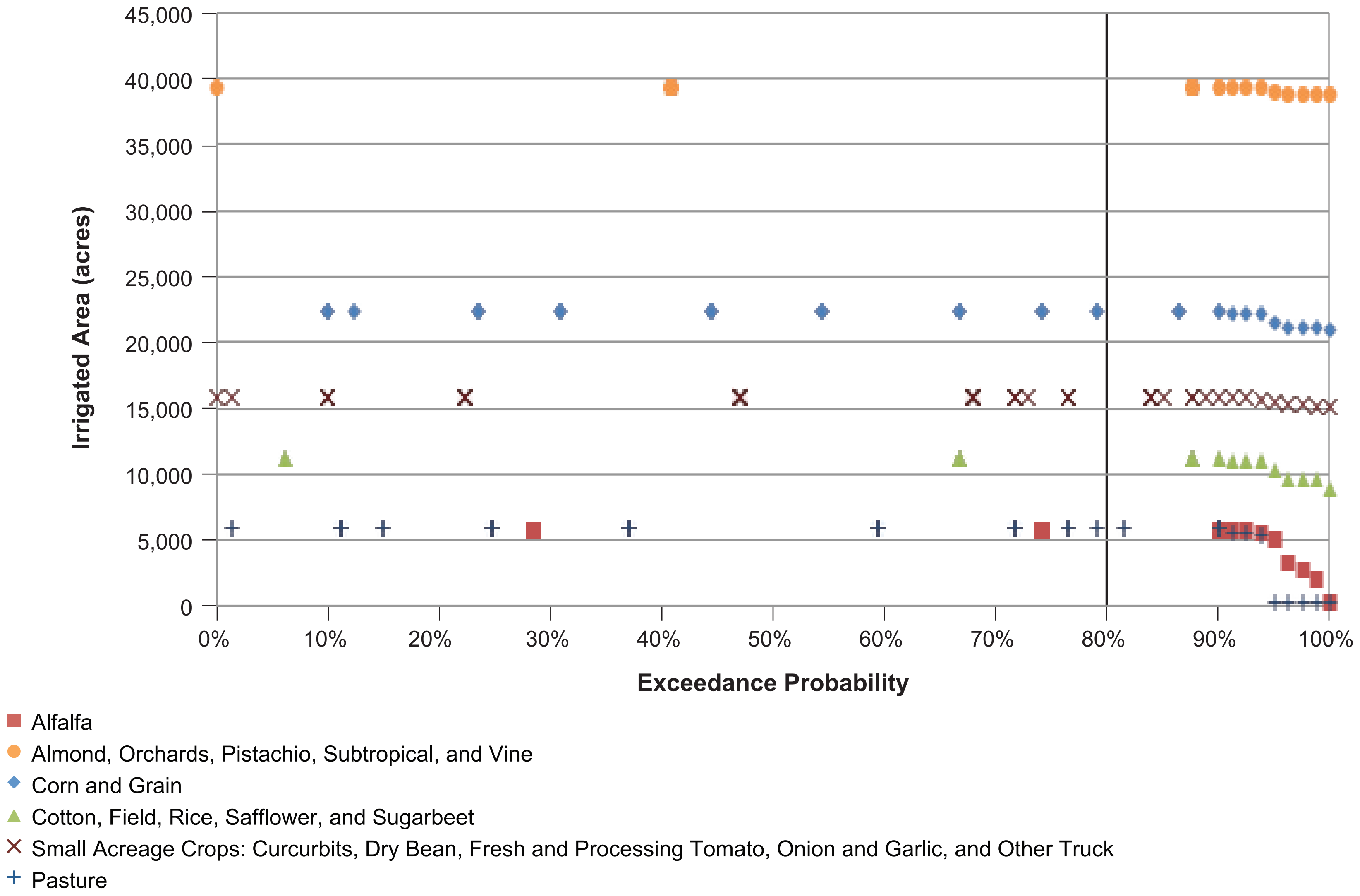

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Figure 11-8
Irrigated Acreage in Merced ID for Baseline

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

The program of implementation for the numeric salinity objectives contained in SDWQ Alternatives 2 and 3 includes continued USBR compliance with the Vernalis salinity requirement currently established in the 2006 *Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan) and implemented through the State Water Board's Water Right Decision 1641 (D-1641). Accordingly, it is expected that salinity conditions in the southern Delta would not be degraded and would not result in significant impacts.

SDWQ Alternatives 2 and 3 include numeric salinity objectives of 1.0 dS/m and 1.4 dS/m, respectively, applicable in all months. The program of implementation for these two alternatives would maintain the EC at Vernalis at or below 0.7 dS/m April–August and 1.0 dS/m September-March, as it is under the current objectives. This would provide some assimilative capacity downstream of Vernalis and protect beneficial agricultural uses. The existing salinity objectives are 0.7 dS/m for April-August and 1.0 dS/m for September-March and, as described in Chapter 5, *Surface Hydrology and Water Quality,* and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, baseline salinity conditions have historically ranged from approximately 0.2 dS/m to 1.2 dS/m. The potential agricultural acreage impact (Impact AG-1 and Impact AG-2 for the SDWQ alternatives) is estimated by assuming year-round irrigation salinity concentrations of 1.0 dS/m and 1.4 dS/m for SDWQ Alternatives 2 and 3, respectively. The analysis compares the associated crop yield impacts for this salinity concentration against crop yields under baseline. Based on the conclusions of Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* baseline salinity conditions are suitable for all agricultural crops, so the crop yield and agricultural acreage impacts of Alternatives 2 and 3 would simply be those associated respectively with 1.0 dS/m and 1.4 dS/m irrigation water salinity concentrations.

The potential for salinity-related impacts was evaluated using the information and modeling approaches contained in Appendix E. It is first determined if significant reductions in agricultural acreage or significant reductions in crop mix or crop production would take place under the SDWQ alternatives using the quantitative and qualitative results presented in Appendix E. These results are then qualitatively discussed as to the expected impacts under each SDWQ alternative with respect to conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses or conversion of farmland to nonfarmland.

Appendix E describes the models that are commonly used when assessing the suitability of a particular water quality (ECw) for crop production. A summary is provided here. Such models estimate the soil water salinity (ECe) that would result from using a certain quality of ECw under specified irrigation management practices (i.e., leaching fraction) and then uses the relationship between salinity and crop yield to develop an estimate of an associated impact. As recommended in Appendix E, the exponential steady-state model results presented in Appendix E are used in this analysis to determine ECe. ECe threshold levels, and the rates at which increasing levels affect crop production, are unique for each crop, a crop's growth stage, and potentially for a cultivar (Ayers and Westcott 1985).

Maas and Hoffman (1977) developed a relationship (Eqn. 11-1) between rootzone salinity and yield decline using the salinity tolerance of crops. This relationship states that at rootzone salinity (ECe) levels greater than a threshold (salinity tolerance of a crop), yield decline begins and increases based on the percent decline for the given increase in salinity (ECe).

$$\text{Yield} = 100\% - \text{slope}\ (\%) * (\text{measured rootzone ECe} - \text{threshold ECe}) \qquad \text{(Eqn. 11-1)}$$

This equation (Eqn. 11-1) uses quantitative salinity tolerance information available for many of the crops grown in the SDWQ area of potential effects, presented in Table 11-13. Relative salt tolerance, on an annual basis, for each crop group is ranked from *sensitive* (S), *moderately sensitive* (MS), *moderately tolerant* (MT), to *tolerant* (T). Qualitative salinity tolerance information, presented in Table 11-14 is available for crops without quantitative data.

As an example, using Eqn. 11-1 above and information from Table 11-13, the decrease in apricot yield can be calculated. Apricots have an ECe tolerance of 1.6 dS/m with a decline of 24 percent for each unit increase in rootzone salinity (ECe). Therefore, using Eqn. 11-1, if the rootzone salinity (ECe) was 2.6 dS/m, then the yield would be expected to decrease by 24 percent, and the total apricot yield would be 76 percent, as presented below in Eqn. 11-2.

$$\text{Apricot yield} = 100\% - 0.24 * (2.6 - 1.6) = 76\% \qquad \text{(Eqn. 11-2)}$$

The methodology uses the results presented in Appendix E for three crops: alfalfa, almonds, and dry beans. All of these crops are grown on significant acreage in the southern Delta (Table 11-9) and have relatively low thresholds to soil salinity (ECe) (Table 11-13). Crops without specific tolerance are listed in Table 11-14. This information can be compared against crops with quantitative data. For example, there is no specific information on apples, but when comparing apples to another sensitive crop (S), yield decline should not occur unless the salinity of the soil extract (ECe) becomes greater than 1 to about 1.5 dS/m. Appendix E presents estimates of soil water salinity and yield impact estimates for dry beans, alfalfa, and almonds across a range of different irrigation water salinity levels and leaching fractions. The analysis considers both a minimum and median level of precipitation, as precipitation influences the level of salinity in the soil, and higher precipitation can result in lower salinity levels. For the purpose of this analysis, a significant impact would result if the impact on crop yield for salt-sensitive crops is greater than 10 percent. Above this level, it would become more difficult for farmers to mitigate impacts with modified irrigation practices (e.g., increased leaching) and would start to substantially reduce the acreage of these types of crops in the southern Delta.

Central Valley Water Board's TMDLs for salt and boron determined that EC objectives protective of beneficial uses in this part of the watershed also protect those uses from the potential impacts from boron. Therefore, boron toxicity to agricultural resources is not considered in this analysis.

Table 11-13. Available Soil Salinity Threshold, Slope Information, and Relative Salinity Tolerance for Crops Grown in within the SDWQ Area of Potential Effects

Crop Category & Crop	Threshold ECe (dS/m)	Slope %/dS/m	Relative Salt Tolerance
Fruits & Nuts			
Apricots	1.6	24	S
Almonds	1.5	19	S
Field Crops			
Cotton	7.7	5.2	T
Sugar Beets	7	5.9	T
Corn	1.7	12	MS
Sudan	2.8	4.3	MT
Dry Beans	1	19	S
Sorghum	6.8	16	MT
Grain & Hay (Wheat)	5.9	3.8	MT
Pasture			
Pasture (clover)	1.5	12	MS
Alfalfa	2	7.3	MS
Truck & Berry			
Asparagus	4.1	2	T
Cole (broccoli)	2.8	9.2	MS
Carrots	1	14	S
Celery	1.8	6.2	S
Cucurbits	2.5	13	MS
Onion & Garlic	1.2	16	S
Tomatoes	2.5	9.9	S
Peppers	1.5	14	MS
Vineyards	1.5	9.6	MS

Source: United States Salinity Lab 2012.

Notes:

1 dS/m = 1000 microSiemens per centimeter (1000 μS/cm).

Because Pasture typically contains a mixture of grasses and legumes, the crop with the lowest tolerance to salinity (clover) was selected to represent all Pasture. United States Salinity Lab quantifies the impact of salinity on crop production and catalogs crops into salt tolerance categories.

SDWQ = southern Delta water quality
ECe = soil salinity
dS/m = deciSiemens per meter
S = sensitive
MS = moderately sensitive
MT = moderately tolerant
T = tolerant

Table 11-14. Relative Salinity Tolerance for Crops Grown within the SDWQ Area of Potential Effects that do not have Quantitative Threshold Information

Crop Category & Crop	Relative Salt Tolerance
Fruits & Nuts	
Apples	S
Olives	T
Walnuts	S
Pistachios	MS
Field Crops	
Safflower	MT
Pasture	
Turf Farm	MT
Truck & Berry	
Green Beans	S

Source: Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*.

Notes:

1 dS/m = 1000 microSiemens per centimeter (1000 µS/cm).

There is no quantitative data for the crops with only the relative salt tolerance information; however, these crops can be compared against crops with quantitative data. For example, there is no specific information on apples, but when comparing apples to another sensitive crop (S), yield decline should not occur unless the salinity of the soil extract (ECe) becomes greater than 1 to about 1.5 dS/m.ECe = soil salinity

SDWQ = southern Delta water quality
dS/m = deciSiemens per meter
S = Sensitive
MS = Moderately sensitive
MT = Moderately tolerant
T = Tolerant

11.5 Impacts and Mitigation Measures

Impact AG-1: Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)* for the No Project Alternative technical analysis.

LSJR Alternatives

The LSJR alternatives would require flows for fish and wildlife beneficial uses in the rivers. As a result, modifications to reservoir operations and reductions in the available surface water supply could result in irrigation diversions. A reduction in water supply availability for irrigation purposes could potentially lead to a reduction in crop acreage and a potential conversion to nonagricultural uses. The precise amount of lands that are designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance that could be converted to nonagricultural uses cannot be precisely quantified. However, potential impacts, based on the crop reduction modeling results, can be qualitatively discussed to determine possible conversion to nonagricultural uses. In other words, the analysis uses decreased crop production as a proxy for potential conversion to nonagricultural uses. Although the reduction in water supply is used as a proxy for the conversion of irrigated land to nonagricultural lands, lands that are not irrigated could remain in agricultural use (as discussed in Impact AG-3). Non-irrigated uses that are still considered agricultural use include dry land farming, fallowing, grazing, dairy, and animal husbandry. Figures 11-9 through 11-14 summarize the results of the SWAP analysis for all crops for each LSJR Alternative compared to the baseline in each of the six geographic areas.

These figures show how irrigated acreage in each water district changes in response to changed water availability under baseline and for each of the LSJR alternatives. Figure 11-9, for example shows that irrigated acreage in SSJID stays the same, at approximately 58,500 acres in most years under baseline. Irrigated acreage, however, starts dropping at the 95 percent exceedance probability—this means that irrigated acreage drops below 58,500 acres about once in every 20 years and can be as low as approximately 44,000 acres. Figure 11-9 also shows that reduction in irrigated acreage is bigger and occurs more frequently under the LSJR alternatives. Under LSJR Alternative 3, there would be no reduction in crop acreage about 62 percent of the time, and 80 percent of the time crop acreage would still be approximately 55,000 acres. Although the lowest irrigated acreage under LSJR Alternative 3 is only slightly lower than under baseline (42,000 acres under LSJR Alternative 3 versus 44,000 acres under baseline), crop acreage would be lower than under baseline in about 38 percent of all years.

LSJR Alternative 2 (Less than significant/Significant and unavoidable with adaptive implementation)

Irrigated crop acreage under LSJR Alternative 2 as estimated by the SWAP model for the 1922–2003 period shows minimal reductions when compared to baseline (Figures 11-9 through 11-14). Average crop acreage and acreage reductions are summarized in Table 11-15. Two of the six districts had none or minimal (Merced ID) acreage reductions. Reductions in the remaining districts ranges from 1.5 to 2.6 percent. The impact is less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation of method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment.

Table 11-15. Average Cropped Acreage and Acreage Reduction under LSJR Alternative 2

	Baseline	LSJR Alternative 2		
District	Average Acres		Acre Change	% Reduction
SSJID	58,229	57,372	-857	1.5
OID	54,162	52,767	-1,395	2.6
SEWD + CSJWCD	98,931	98,931	0	0.0
MID	57,354	56,143	-1,211	2.1
TID	143,783	141,183	-2,600	1.8
Merced ID	99,769	99,747	-22	0.0
Total	512,229	506,144	-6,086	1.2

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Conservation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

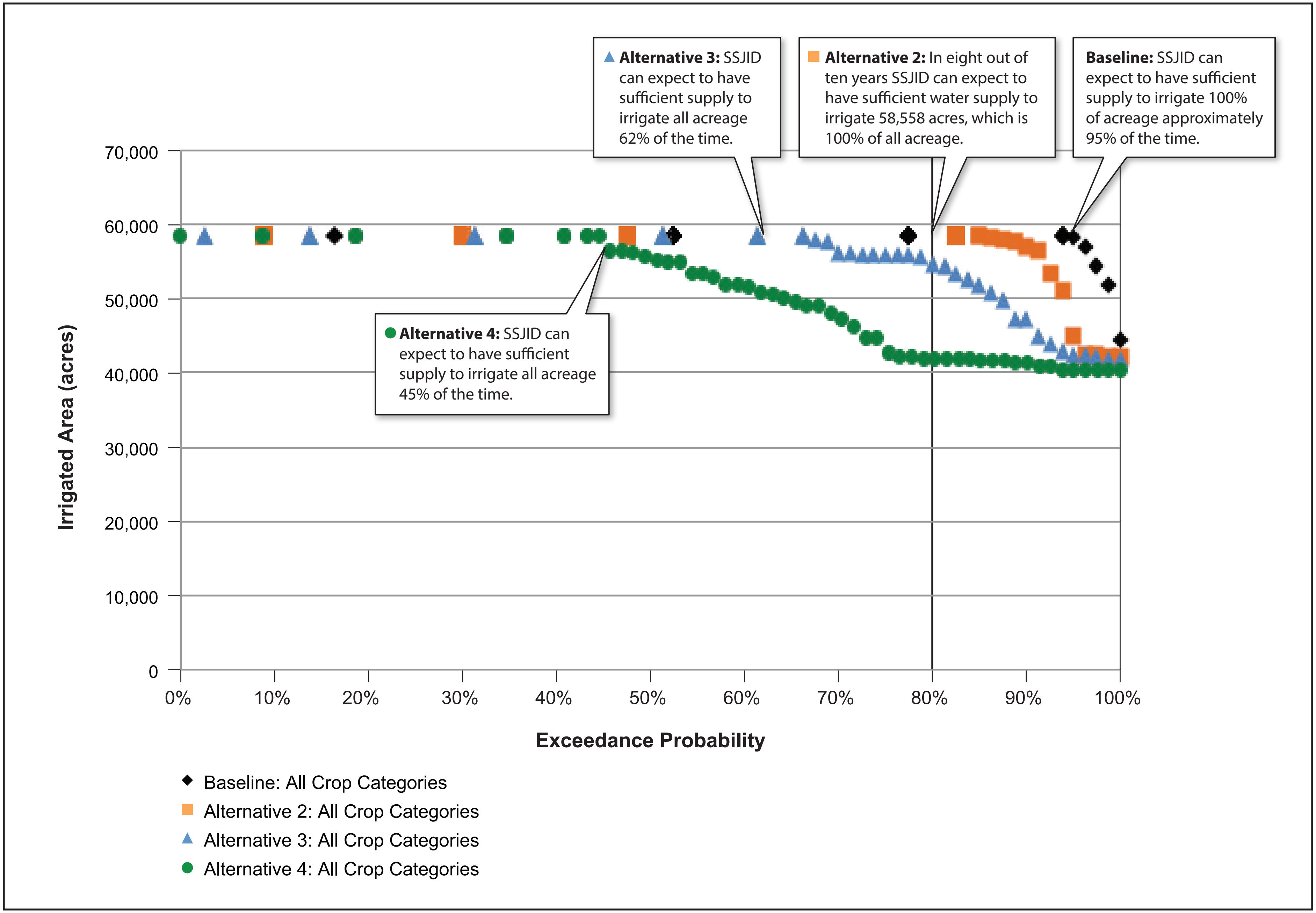
If the adjustment occurs frequently or for extended durations, impacts under LSJR Alternative 2 could become more like the impacts under LSJR Alternative 3. At 30 percent unimpaired flow, the average acreage reduction for all irrigation districts increases from 1.2 percent (Table 11-15) to 2.3 percent (Table 11-16). Reductions in average acreage at the district level ranges from none for SEWD & CSJWCD to 4.5 percent for MID (Table 11-16). When the maximum groundwater pumping capacity for 2014 is used in the analysis instead of the estimates for 2009, the acreage is less affected because increased groundwater pumping can meet the shortfall in the applied surface water needed to meet crop demand.

Table 11-16 Average Baseline and Crop Production 2009 and 2014 Groundwater Pumping under LSJR Alternative 2 with Adaptive Implementation

	2009 Groundwater Pumping			2014 Groundwater Pumping[a]		
	Baseline	30 PCT		Baseline	30 PCT	
District	Acres		% Reduction		Acres	% Reduction
SSJID	58,229	56,806	2.4	58,385	57,367	1.7
OID	54,162	51,806	4.4	54,414	52,865	2.8
SEWD & CSJWSD	98,931	98,931	0.0	98,931	98,931	0.0
MID	57,354	54,765	4.5	58,833	58,584	0.4
Turlock ID	143,783	138,550	3.6	146,006	144,129	1.3
Merced ID	99,769	99,544	0.02	99,769	99,544	0.2
	512,229	500,401	2.3	516,339	511,420	1.0

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Conservation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
Merced ID = Merced Irrigation District

[a] TID baseline increased by 182 acres with 2014 groundwater pumping.



▲ **Alternative 3:** SSJID can expect to have sufficient supply to irrigate all acreage 62% of the time.

■ **Alternative 2:** In eight out of ten years SSJID can expect to have sufficient water supply to irrigate 58,558 acres, which is 100% of all acreage.

Baseline: SSJID can expect to have sufficient supply to irrigate 100% of acreage approximately 95% of the time.

● **Alternative 4:** SSJID can expect to have sufficient supply to irrigate all acreage 45% of the time.

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Figure 11-9
Irrigated Acreage in SSJID for All Crops, All Alternatives, and Baseline

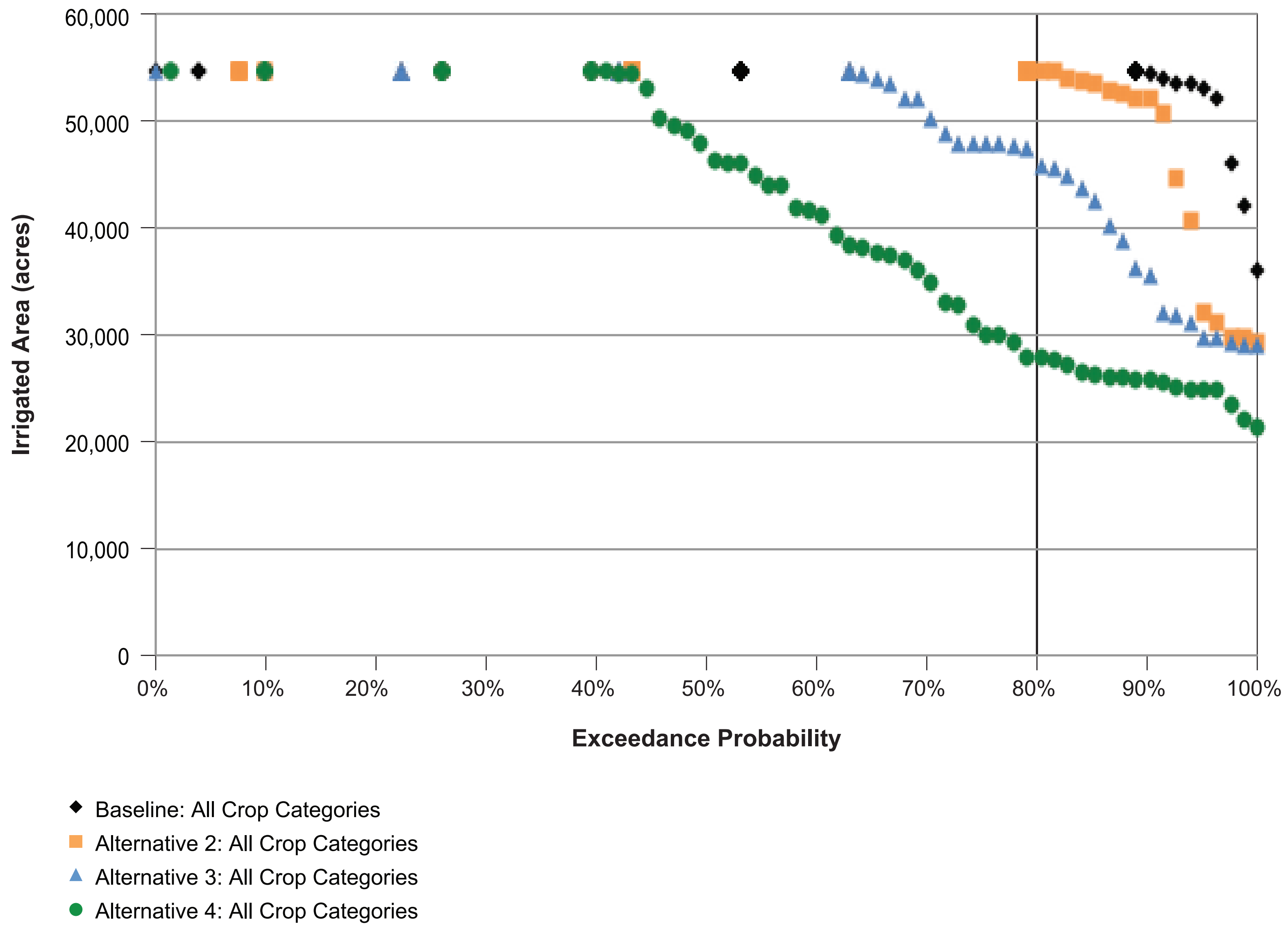

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Figure 11-10
Irrigated Acreage in OID for All Crops, All Alternatives, and Baseline

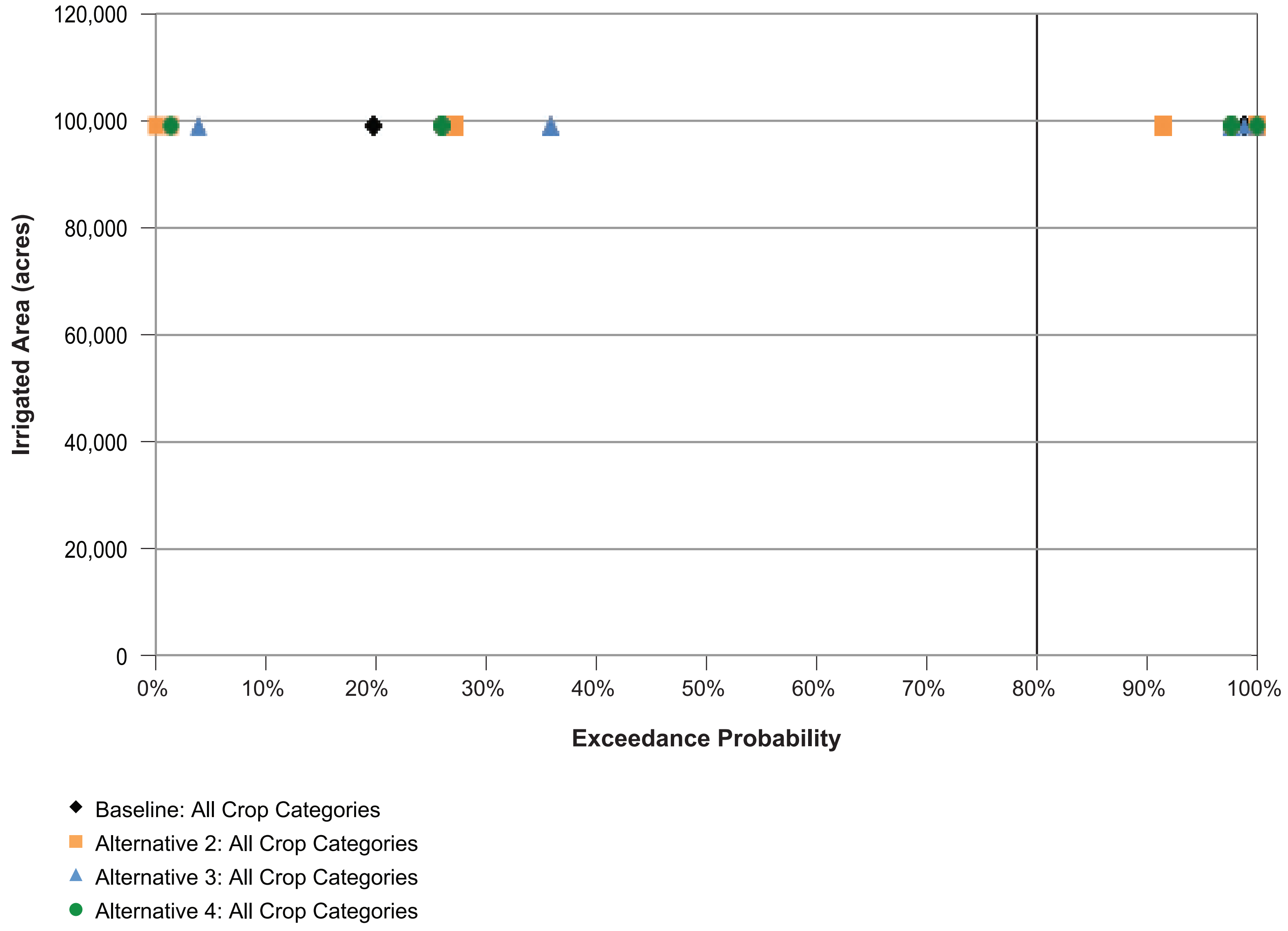

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Figure 11-11
Irrigated Acreage in SEWD and CSJWCD for All Crops, All Alternatives, and Baseline

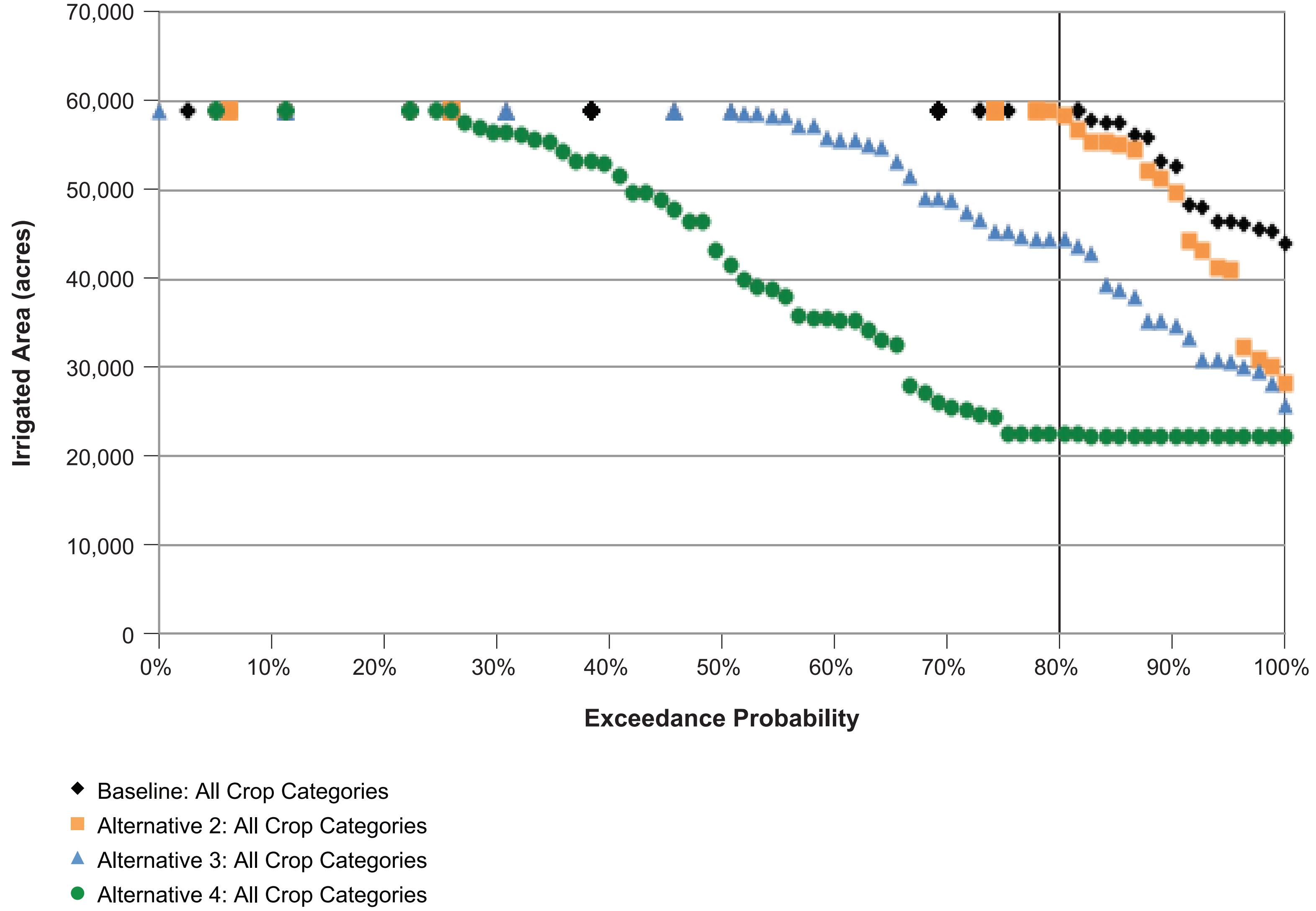

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Figure 11-12
Irrigated Acreage in MID for All Crops, All Alternatives, and Baseline

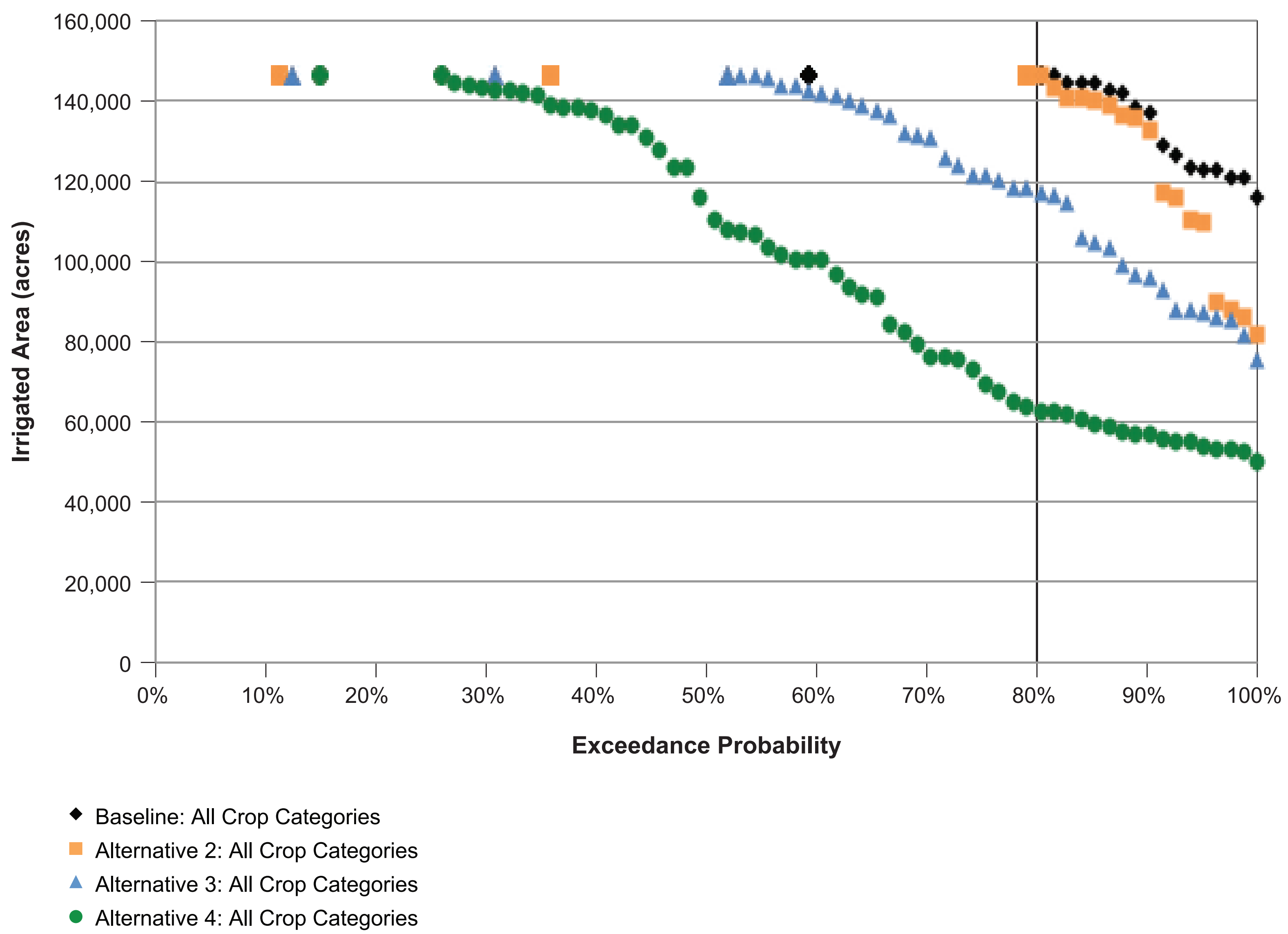

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Figure 11-13
Irrigated Acreage in TID for All Crops, All Alternatives, and Baseline

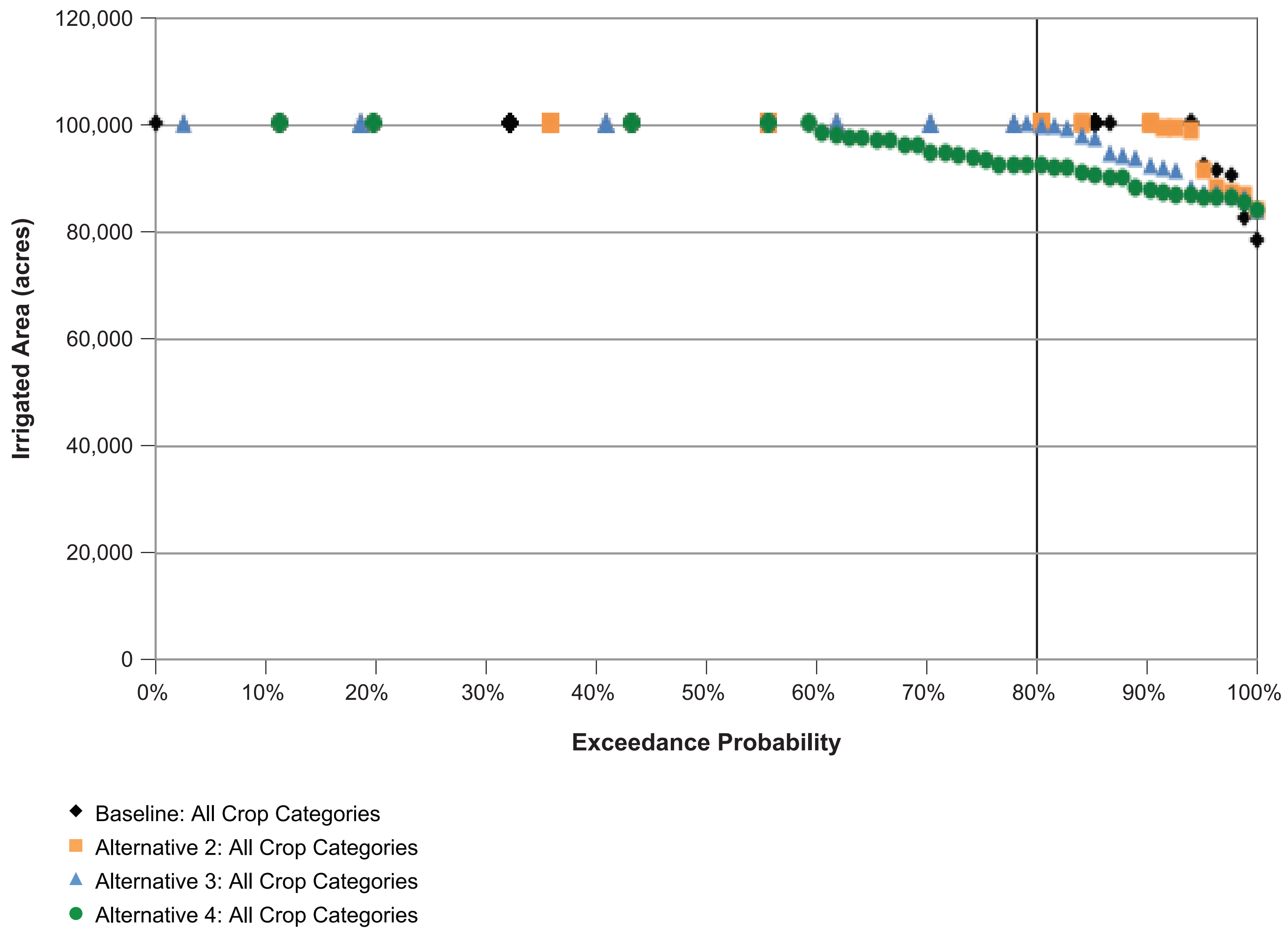

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Figure 11-14
Irrigated Acreage in Merced ID for All Crops, All Alternatives, and Baseline

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February-June timeframe. While the total volume of water released February-June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. It is unlikely that alteration of the timing of the river flows under method 2 would result in substantial modification to the April–September (e.g., irrigation season) diversions. Although method 2 could result in a change in flow during April through June, the total volume of water required for river flow would be the same and, therefore, there would be little change in the volume of water available for agriculture. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. The WSE model results indicate changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR, and thus would not affect agricultural resources. Accordingly, LSJR Alternative 2, with the incorporation of adaptive implementation methods 2, 3, and 4, would not affect agricultural resources, and impacts would be less than significant.

Although adaptive implementation methods 2, 3, and 4 would not cause significant impacts, this impact is still considered to be significant as a result of adaptive implementation method 1. If method 1 is used to increase the required percent of unimpaired flow to 30 percent unimpaired flow on a long-term basis, it is estimated that OID would experience an average decrease in irrigated acreage of 4.4 percent and MID would experience an average reduction in irrigated acres of 4.5 percent under 2009 conditions (Table 11-16). Therefore, impacts would be significant.

Mitigation Measures

A SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777(b)(3).) Local land use agencies can mitigate for the loss of farmland to urban development through development conditions such as in lieu fees for, or direct purchases of, agricultural conservation easements. In addition, local water suppliers, regional groundwater management agencies, and irrigation districts could reduce potential conversion of agricultural land due to reduced surface water availability by requiring modifications to existing agricultural practices that increase irrigation efficiency. To some extent, irrigation efficiencies have already resulted from the implementation of SBX7-7 requirements (see Section 11.3, *Regulatory Background*). Implementing irrigation efficiency measures could reduce the overall amount of irrigation water needed because the water applied to the crops would have fewer losses to deep percolation and surface runoff. The conserved water would then be available for application to additional acreage, thus reducing the likelihood of conversion to nonagricultural use. Increasing the irrigation efficiency could be accomplished with the following methods.

- Increase the use of irrigation management services to better determine how much water is needed by a crop and when to apply it.
- Convert less efficient irrigation systems (e.g., surface irrigation) to more efficient ones (e.g., microirrigation).

- Increase the capability of irrigation water suppliers to provide delivery flexibility, such as the use of irrigation district regulating reservoirs, to allow flexible delivery durations, scheduling, and flow rates.

The measures identified above, such as agricultural conservation easements, could be adopted as project-level measures for project-specific development. Individual projects will be subject to the appropriate level of environmental review at the time they are proposed, and mitigation would have to be identified to avoid or reduce significant effects, prior to any project-level action. Some potential actions, however, may not require discretionary approvals and may not be subject to project-level CEQA review. Nevertheless, local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or under other local authorities, adopt the relevant mitigation measures identified above.

The State Water Board has authority to take action to prevent waste, unreasonable use, unreasonable method of use, and unreasonable method of diversion of water. The State Water Board may exercise this authority through quasi-adjudicative or quasi-legislative proceedings. However, such proceedings are not part of this project. It is also infeasible for the State Water Board to impose mitigation measures at this time because it is undertaking a programmatic analysis of the potential agricultural resource impacts, does not now have specific facts associated with an individual project to legally and technically impose requirements related to waste and unreasonable use, and it is speculative whether these actions would reduce conversions of agricultural lands. In addition, while the State Water Board may impose water conservation or efficiency requirements through the adoption of regulations, the amount of time, high cost, and commitment of staff resources associated with such rule-making proceedings also renders adopting the mitigation measures now infeasible. Adopting regulations right now would require considerable staff time to research, formulate and develop, require extensive stakeholder outreach, and require numerous public meetings before the regulations would take effect. The State Water Board currently has limited resources to pursue adoption of such regulations as most of its budget for the water right program is supported by fees imposed on water right permit and license holders, and is used for program activities related to the diversion and use of water subject to the permit and license system. Only a small amount of funding is available for other regulatory activities and it is speculative to anticipate that additional funding will be made available. Therefore, at this time the imposition of the above mitigation measures is infeasible and impacts under LSJR Alternative 2 with adaptive implementation would remain significant and unavoidable.

While it is possible that some of the water-diversion and use measures, including irrigation efficiency, may have some applicability to reducing impacts or could be implemented as part of the individualized water right proceedings that are expected to take place to implement the flow objectives, any application of these measures at this point by the State Water Board is infeasible for the reasons stated above. Furthermore, it is unknown whether these activities would reduce the significant impacts to less-than-significant levels. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies can and should adopt irrigation efficiencies and local land use authorities can and should impose development conditions and require conservation easements where allowed to mitigate for the loss of agricultural lands to urbanization; however, given the uncertainty of the extent to which these mitigation measures would occur and because they may not fully mitigate impacts, impacts would remain significant. As such, according to the number of acres that would no longer be considered Prime Farmland, Unique Farmland, or Farmland of Statewide Importance as predicted by the SWAP model and the possibility of conversion of these acres to nonagricultural land uses, impacts on agricultural resources under LSJR Alternative 2 with adaptive implementation would remain significant and unavoidable.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Under LSJR Alternative 3, the average annual reduction in acreage ranges from a low of 0.0 percent for SEWD and CSJWCD to just under 10 percent for MID (Table 11-17). While the SWAP results indicated there would be little to no change in crop acreage for either SEWD/CSJWCD or Merced ID, the remaining irrigation districts could experience change in crop acreage of various crop categories.

Crops categories that would experience greater than 1 percent average acreage reduction are shown in Figures 11-15 through 11-18 for SSJID, OID, MID, and TID, respectively for illustration purposes. These figures illustrate how the acreage of select crops change in response to reduced water availability, under both baseline and Alternative 3. Figure 11-15a, for example, shows the irrigated acreage in SSJID for alfalfa. Under baseline, acreage remains stable, at approximately 3,200 acres, in a little over 95 percent of all years, and then is reduced to less than 200 acres. This is reflective of the response to reduced water availability that occurs about once in every 20 years under baseline. Acreage also remains stable under Alternative 3 in approximately 65 percent of years, but then drops a little in about 10 percent of years, followed by a dramatic drop in acreage to 200 acres or less in approximately 17 percent of years. These figures show how the average reductions in crop acreages are concentrated in years with reduced water availability, and vary depending on crop type. Figures are not shown for crops that are not much affected by reduced water supplies, such as orchards, vines, and truck crops (see Appendix G tables G.4-6a through G.4-6f).

Table 11-17. Average Cropped Acreage and Acreage Reduction under LSJR Alternative 3, by District, Compared to Baseline

	Baseline	LSJR Alternative 3		
District	Average Acres		Acre Change	% Reduction
SSJID	58,229	55,951	-2,277	3.9
OID	54,162	50,184	-3,978	7.3
SEWD + CSJWCD	98,931	98,931	0	0.0
MID	57,354	51,685	-5,670	9.9
TID	143,783	132,830	-10,954	7.6
Merced ID	99,769	98,970	-800	0.8
Total	512,229	488,551	-23,679	4.6

Since the crop categories within the six geographic areas need irrigation in 8 out of 10 years to qualify as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, implementing LSJR Alternative 3 could potentially reduce the total lands classified as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance. When the maximum groundwater pumping capacity scenario for 2014 is used in the analysis instead of the estimates for 2009, the acreage is less affected because there was more groundwater pumping in 2014 to meet the shortfall in the applied surface water needed to meet crop demands. The results show an overall decrease in the reduction of average annual crop acreage for all irrigation districts, but particularly MID (Table 11-18). If the groundwater pumping capabilities of the irrigation districts are closer to the 2014 values, then the crop acreage reductions estimated under 2009 conditions would be smaller; however, it is unlikely this is a sustainable practice given groundwater conditions (Chapter 9, *Groundwater Resources*).

Table 11-18. Percent Average Acreage Reduction from Baseline for Irrigation Districts Impacted under LSJR Alternative 3 for 2009 and 2014 Groundwater Pumping Levels

	Groundwater Pumping Level	
	2009	2014
District	% Reduction	
SSJID	4	3
OID	7	5
MID	9	1
TID	8	3

SSJID = South San Joaquin Irrigation District
OID = Oakdale Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District

It is unknown whether the reduction in irrigation water would result in a direct conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use, but it is conservative to assume that if irrigation water is unavailable to sustain these specific crop categories identified in Table 11-17, then some of the 22,879 acres affected, on average, in SSJID, OID, MID, and TID (7.3 percent of the total Prime Farmland, Unique Farmland, and Farmland of Statewide Importance within the affected districts) would be converted to nonagricultural uses. While it would be speculative to quantify the amount of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance that might be converted, the substantial reduction in these types of existing irrigated agricultural lands, as a result of LSJR Alternative 3, could result in their conversion to nonagricultural uses, in which case impacts would be significant.

Similar to the availability of feasible mitigation above under LSJR Alternative 2 (20 percent unimpaired flow), while it is possible that some of the water-diversion and use measures, including irrigation efficiency, may have some applicability to reducing impacts or could be implemented as part of the individualized water right proceedings that are expected to take place to implement the flow objectives, any application of these measures at this point by the State Water Board is infeasible as explained in LSJR Alternative 2. Furthermore, it is unknown whether these activities would reduce the significant impacts to less-than-significant levels. Local water districts and suppliers,

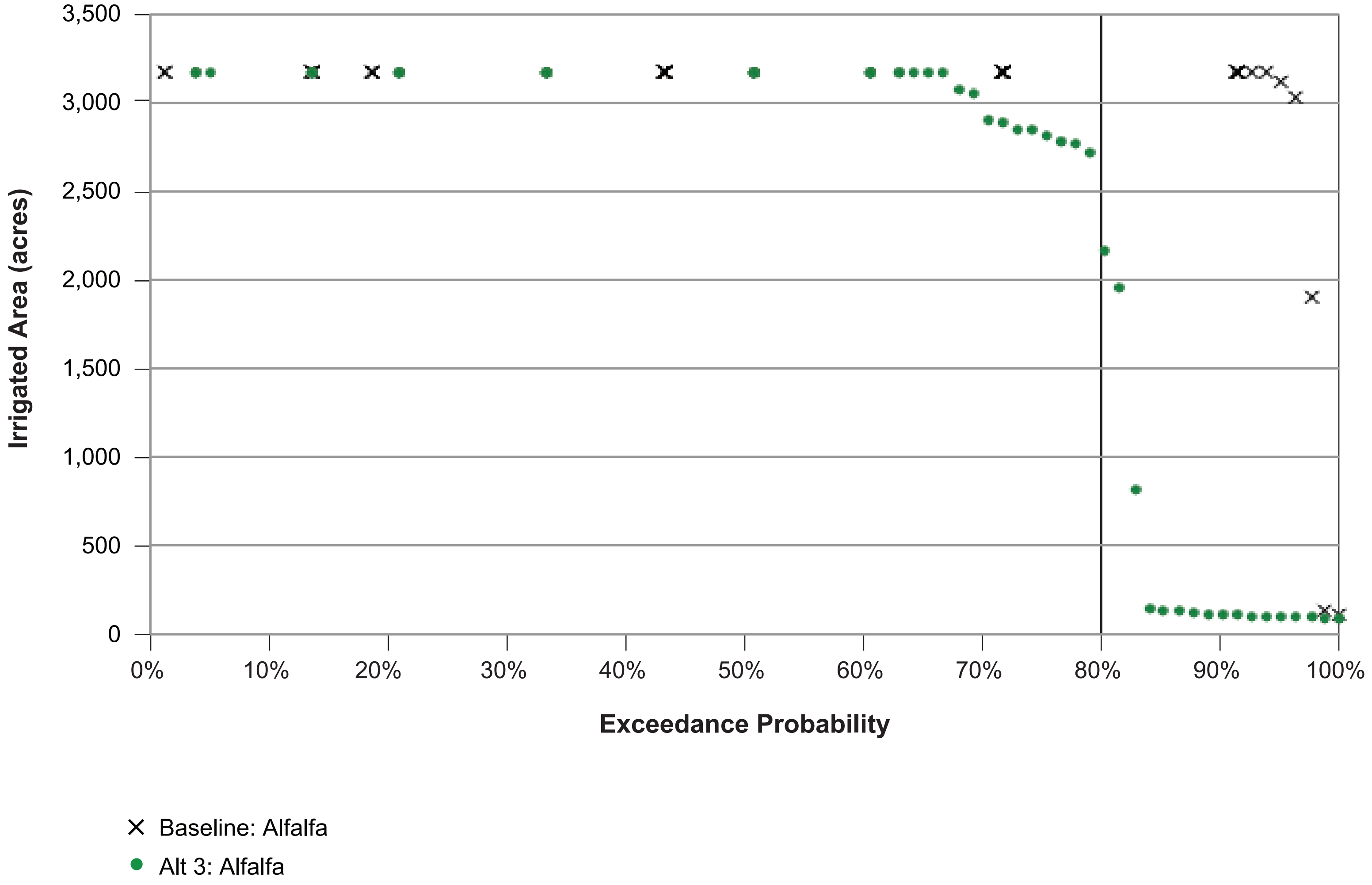

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Figure 11-15a
Irrigated Acreage in SSJID for Alfalfa under Alternative 3

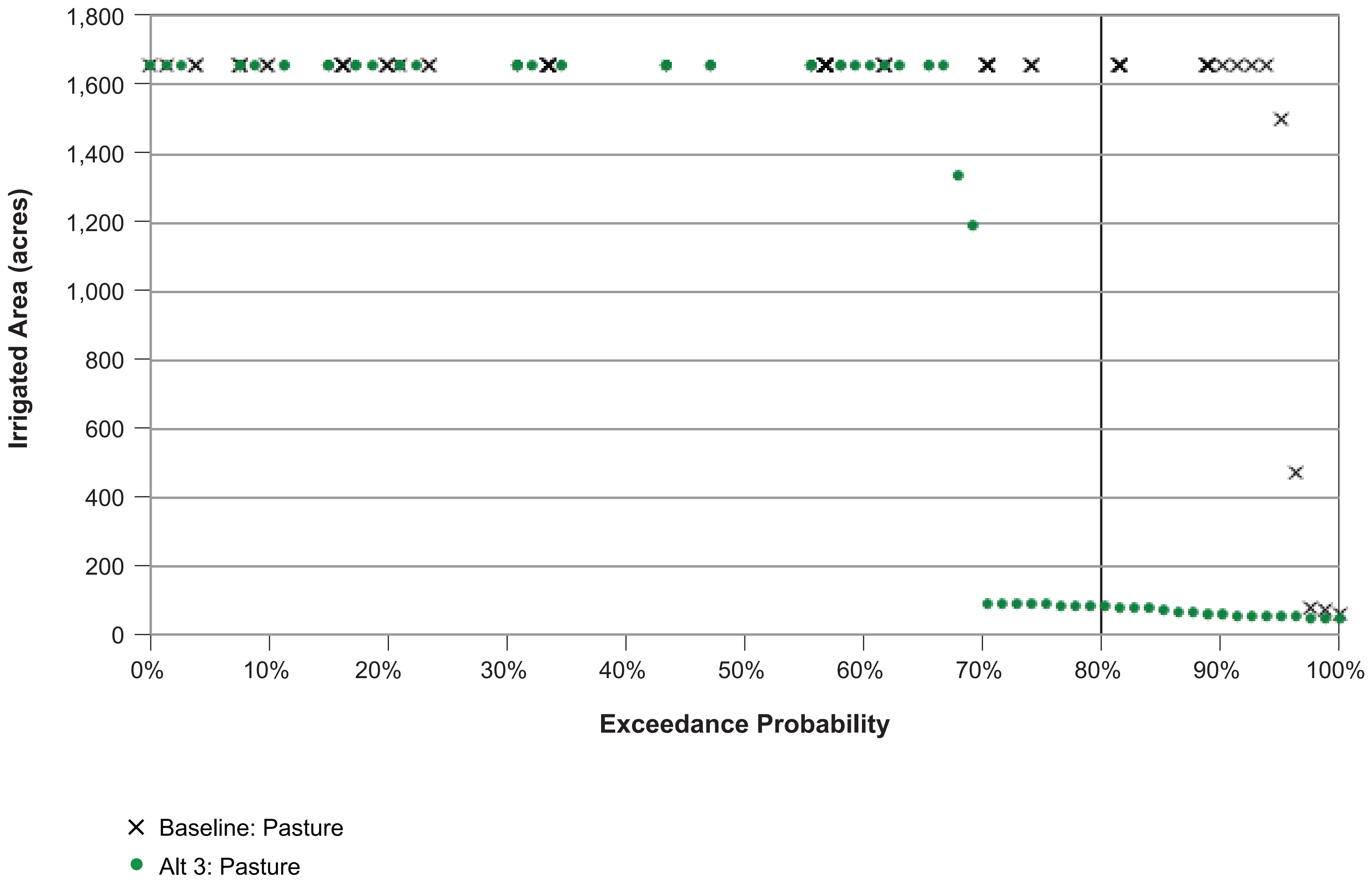

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Figure 11-15b
Irrigated Acreage in SSJID for Pasture under Alternative 3

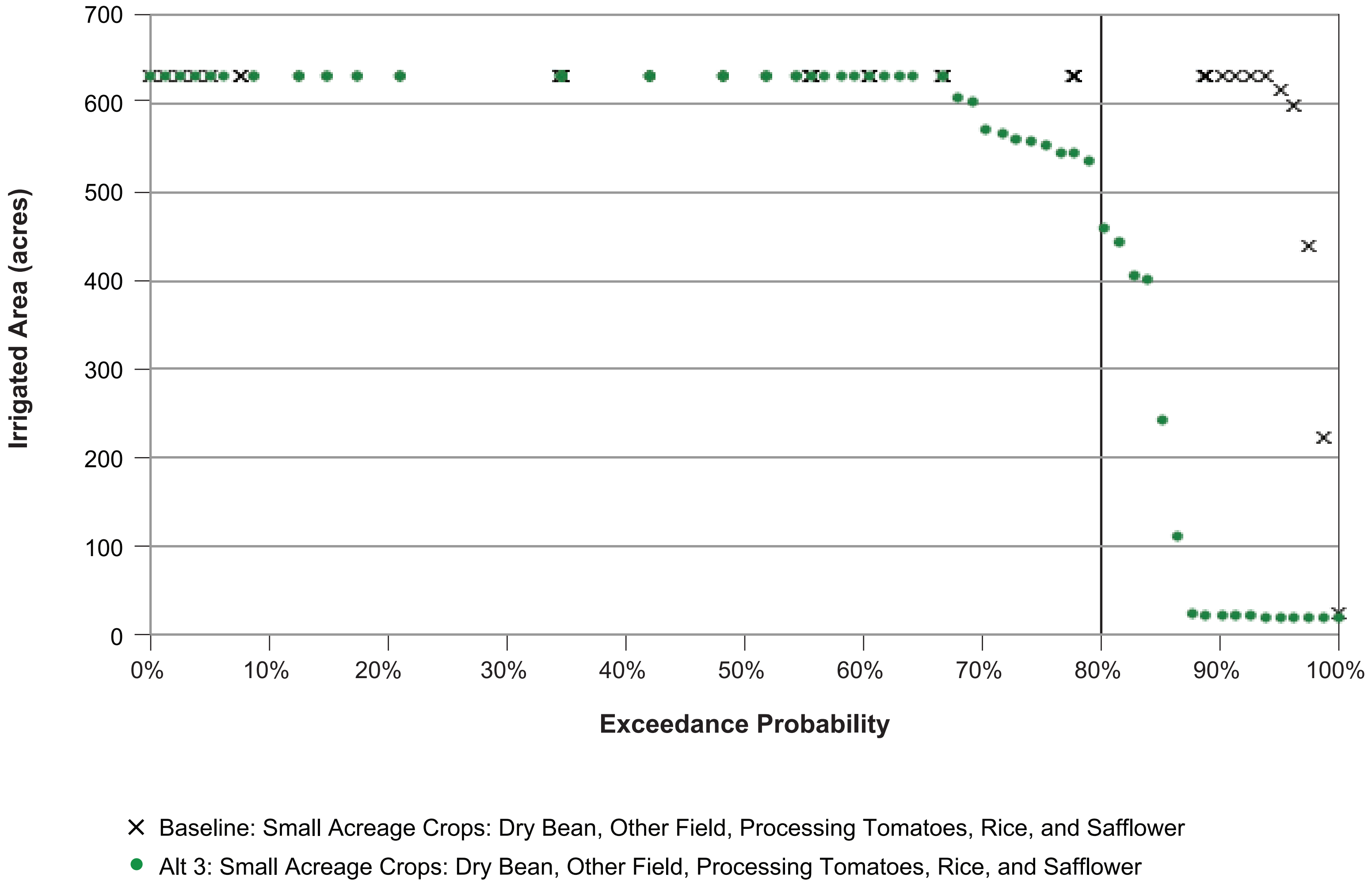

Figure 11-15c
Irrigated Acreage in SSJID for Small Acreage Crops under Alternative 3

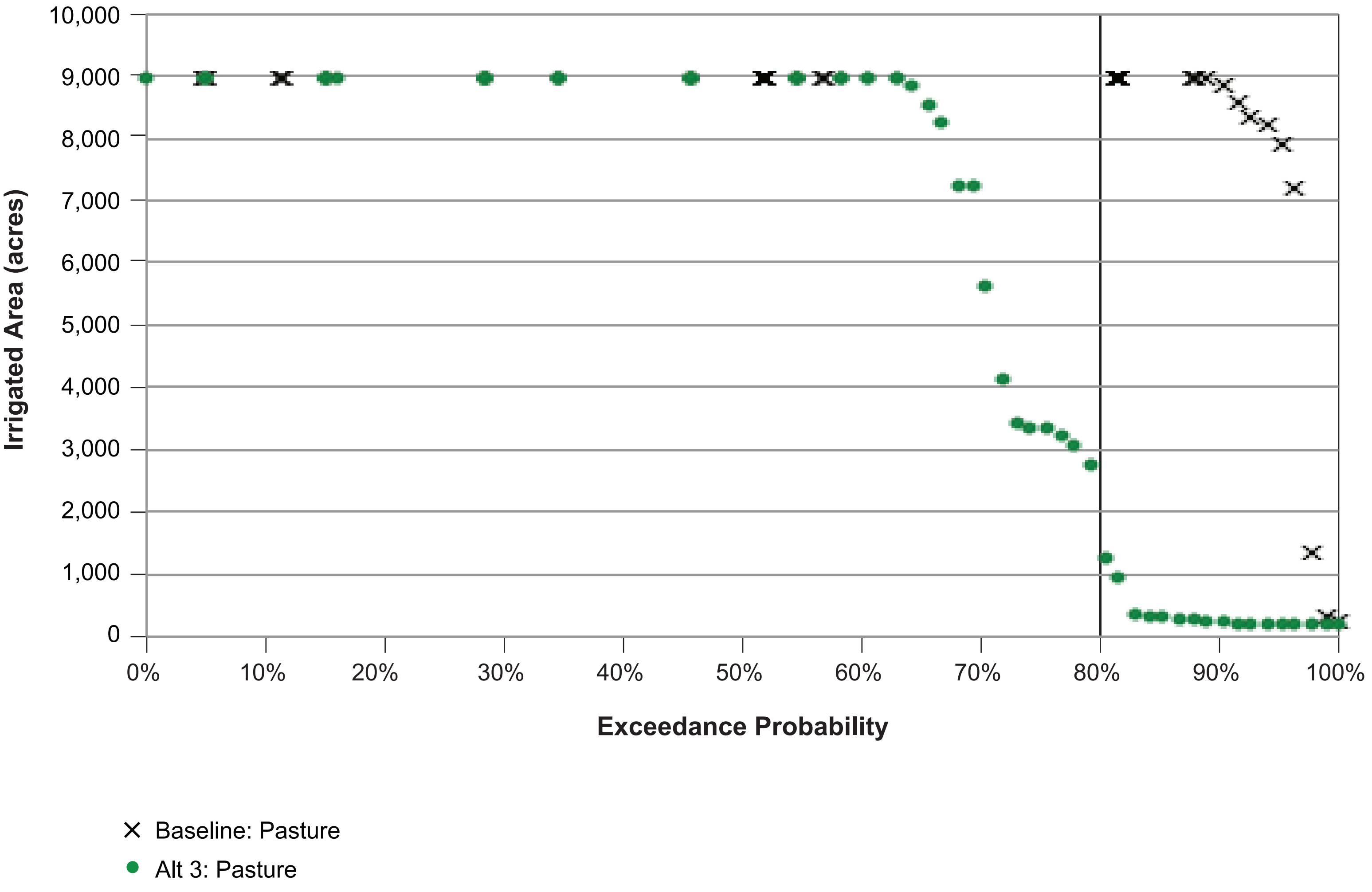

Figure 11-16
Irrigated Acreage in OID for Pasture under Alternative 3

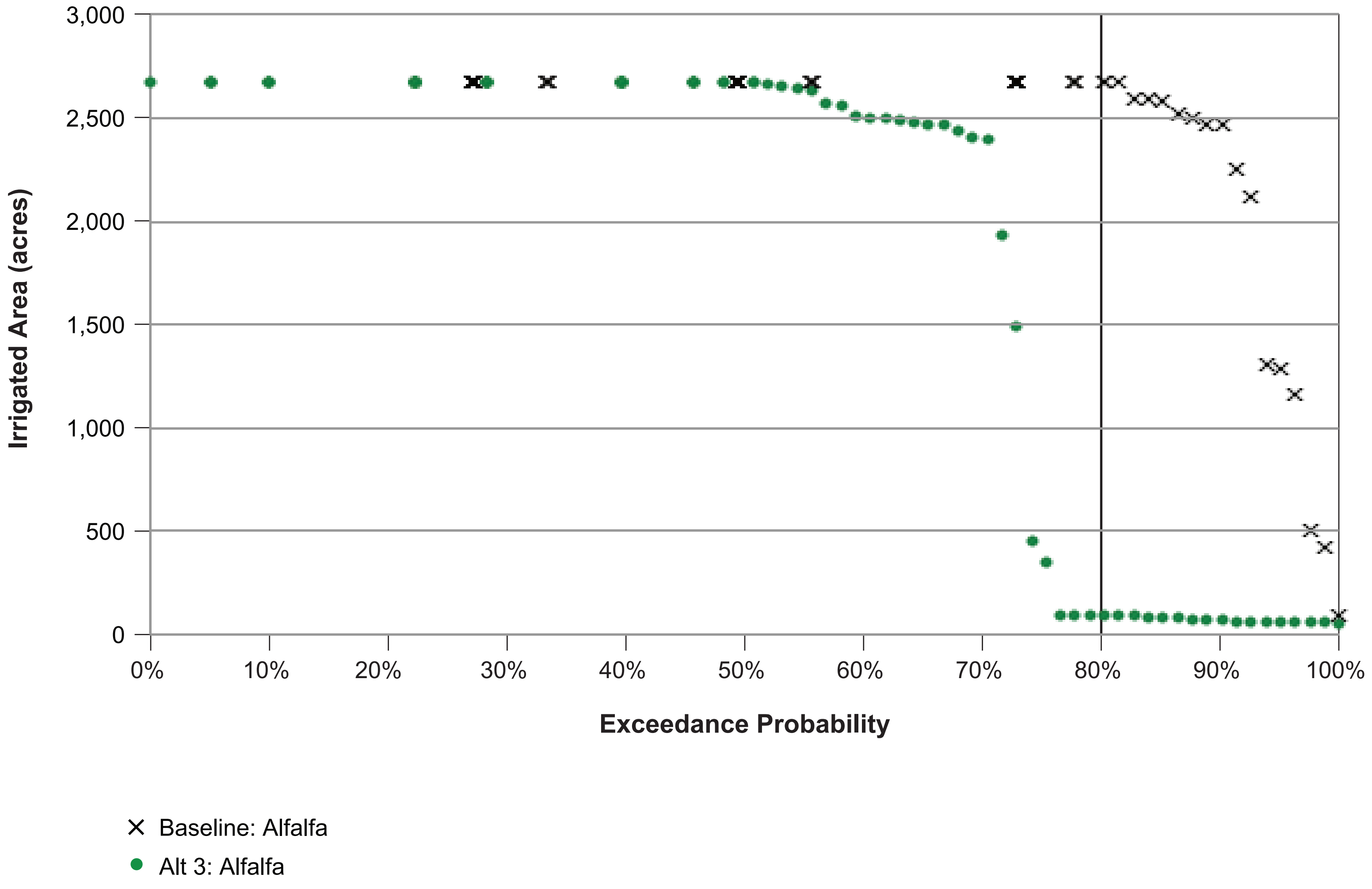

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Figure 11-17a
Irrigated Acreage in MID for Alfalfa under Alternative 3

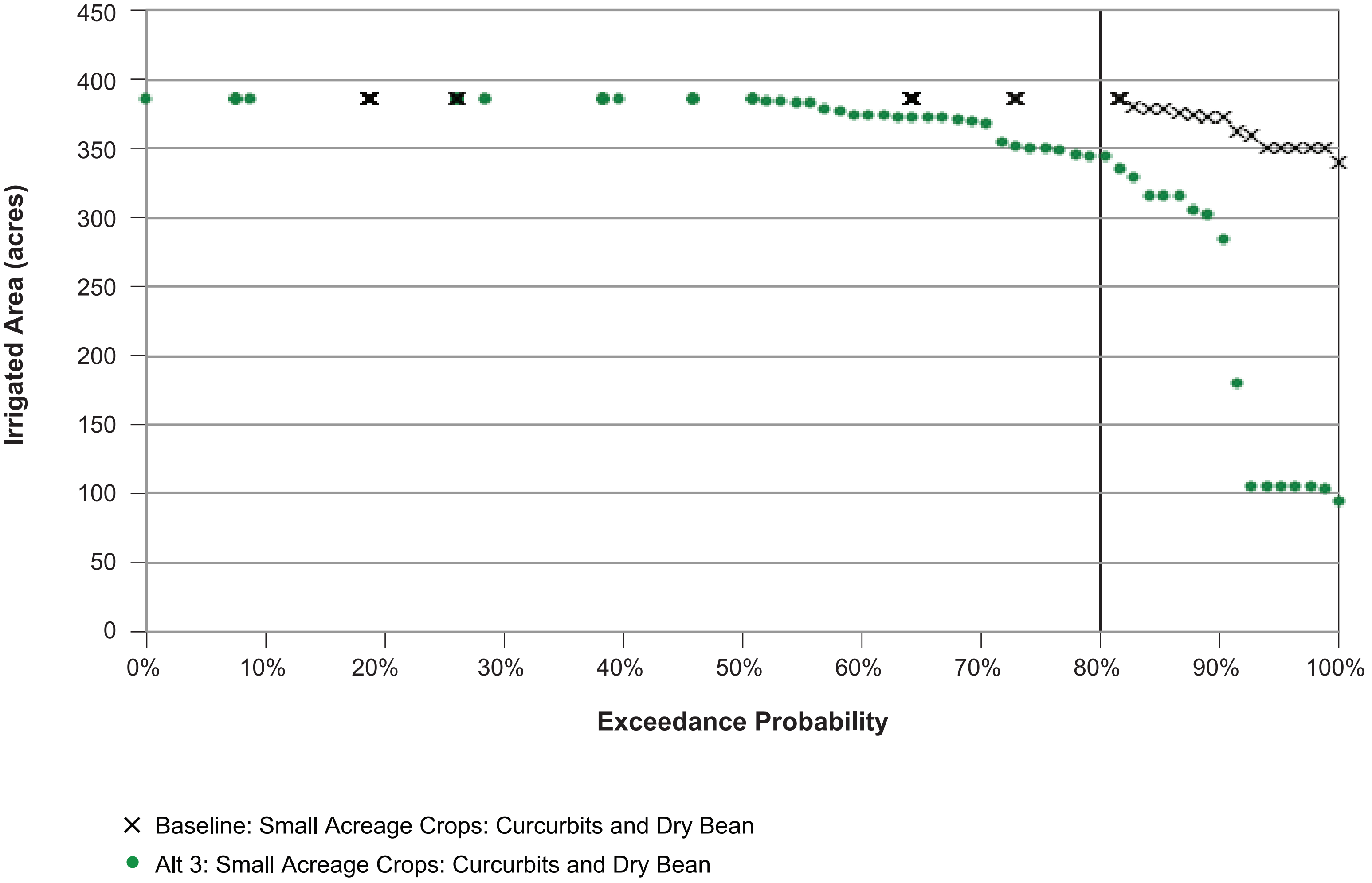

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Figure 11-17b
Irrigated Acreage in MID for Small Acreage Crops under Alternative 3

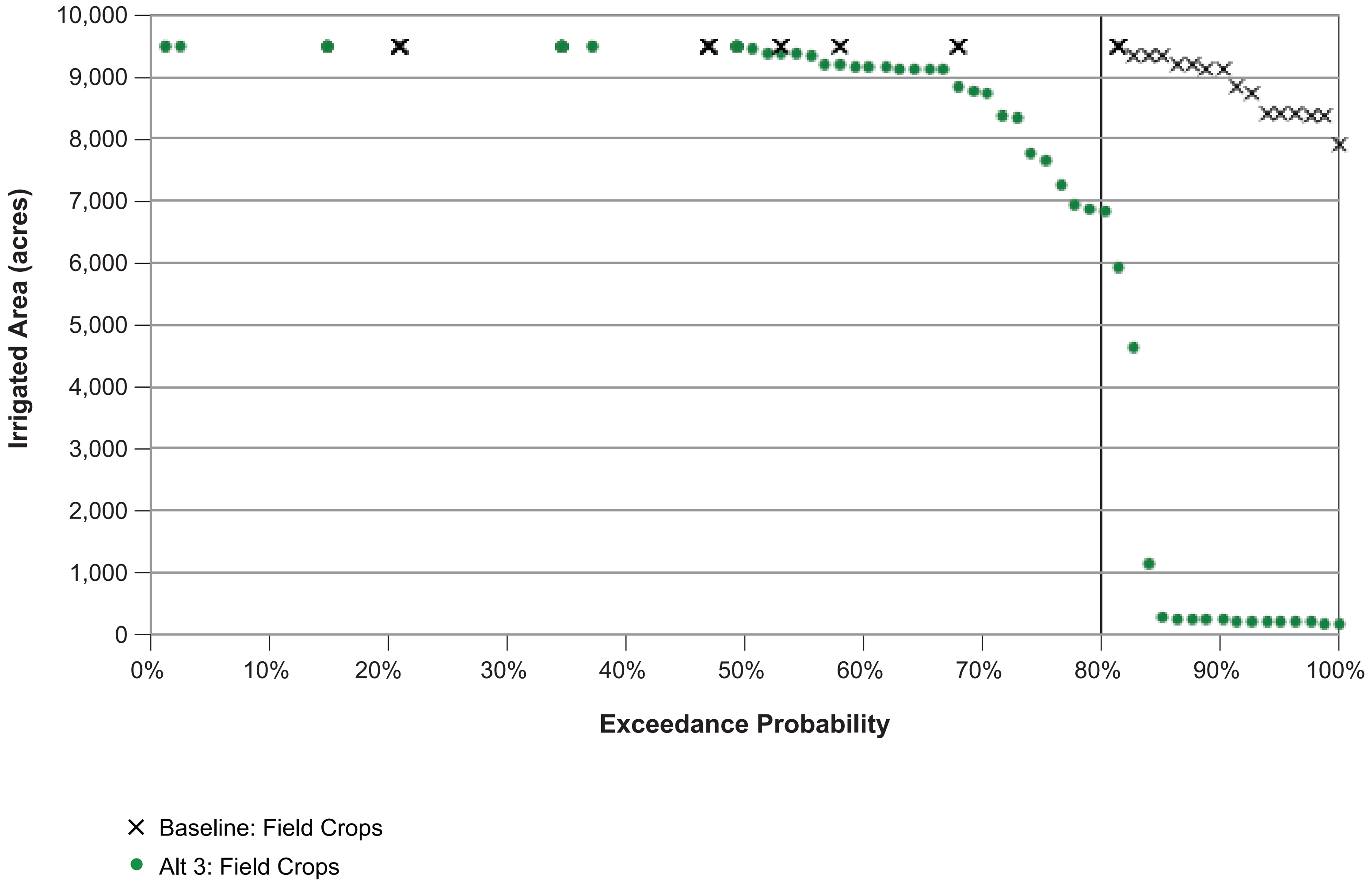

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Figure 11-17c
Irrigated Acreage in MID for Field Crops under Alternative 3

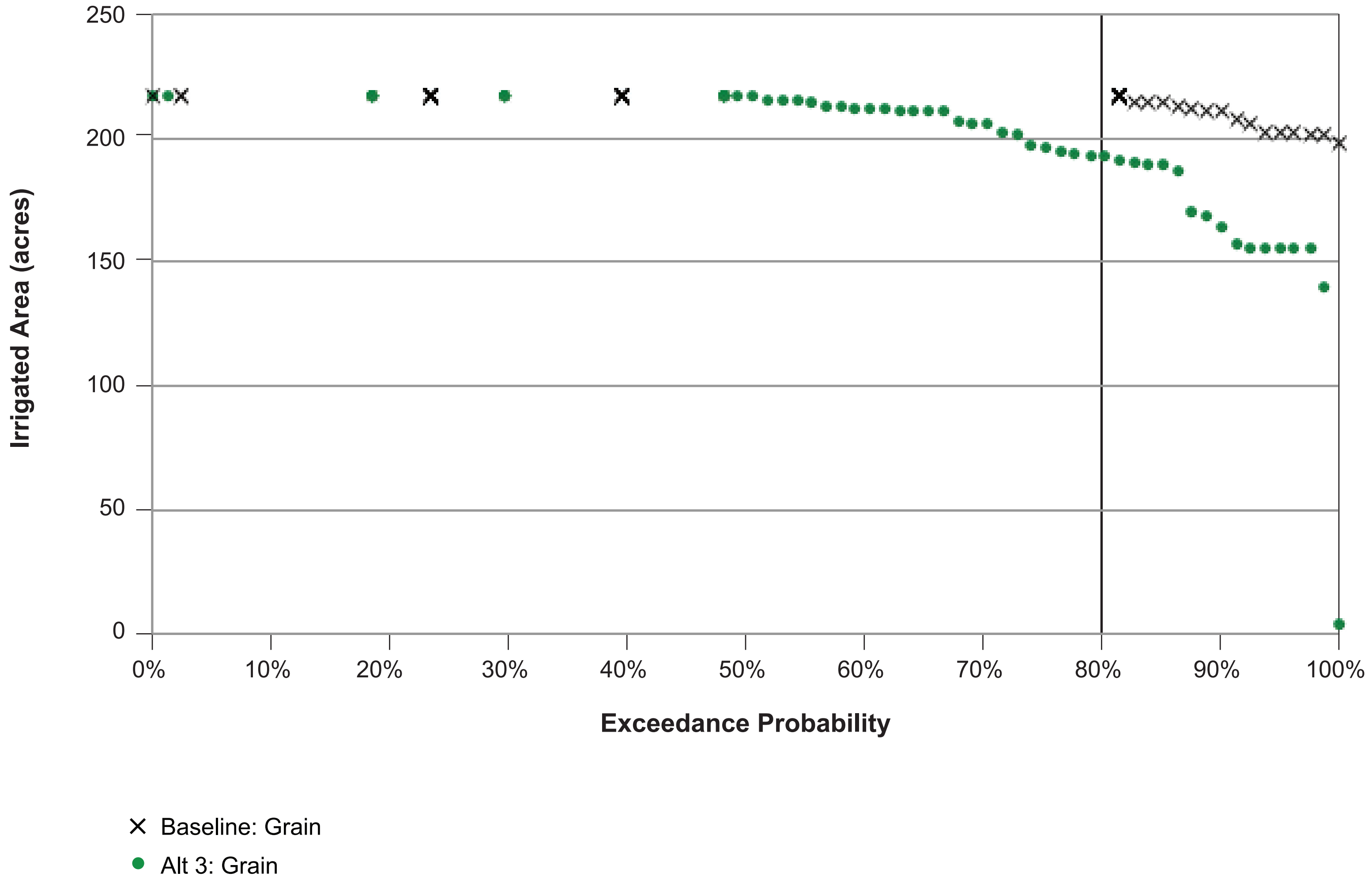

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Figure 11-17d
Irrigated Acreage in MID for Grain under Alternative 3

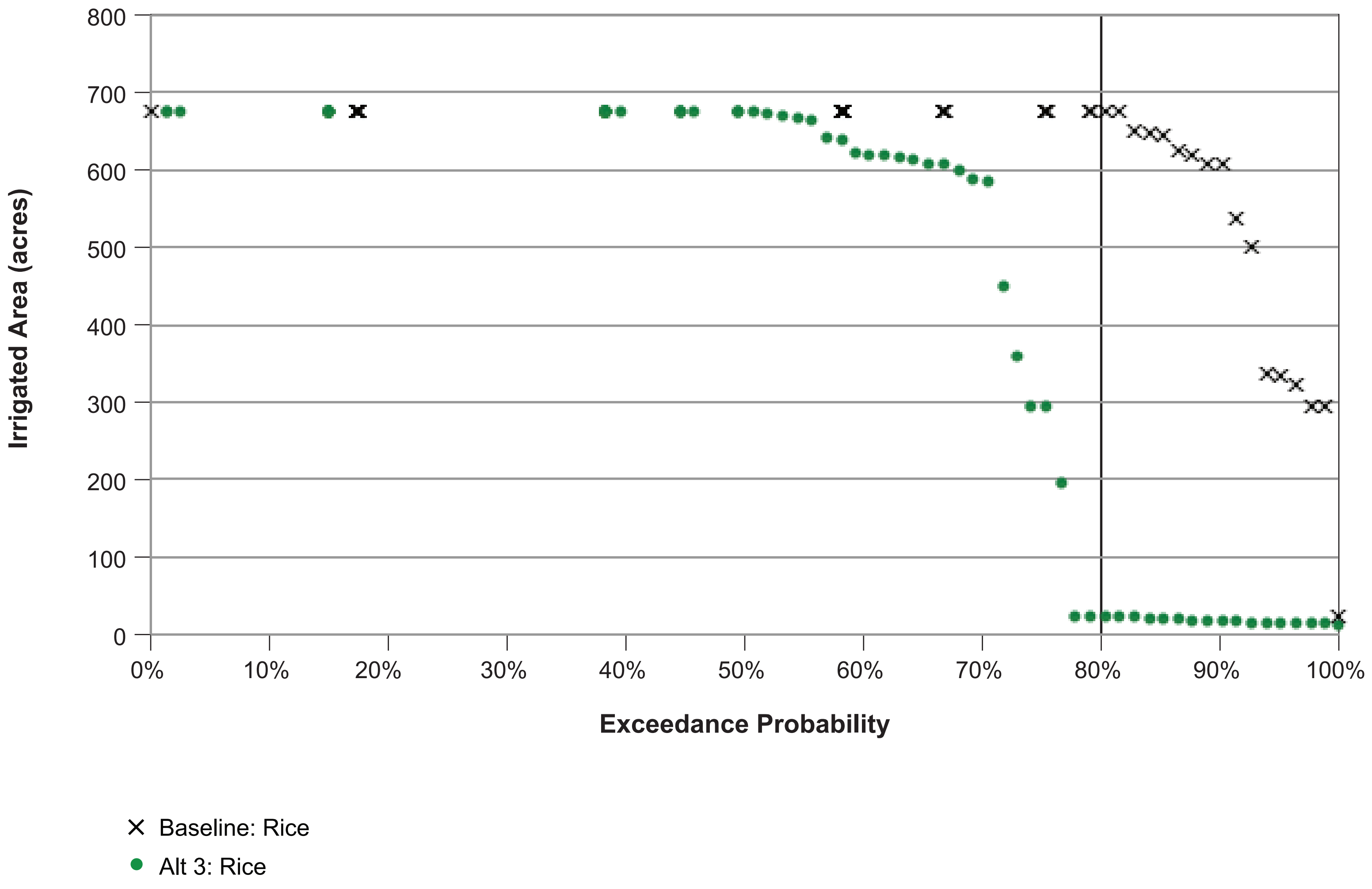

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Figure 11-17e
Irrigated Acreage in MID for Rice under Alternative 3

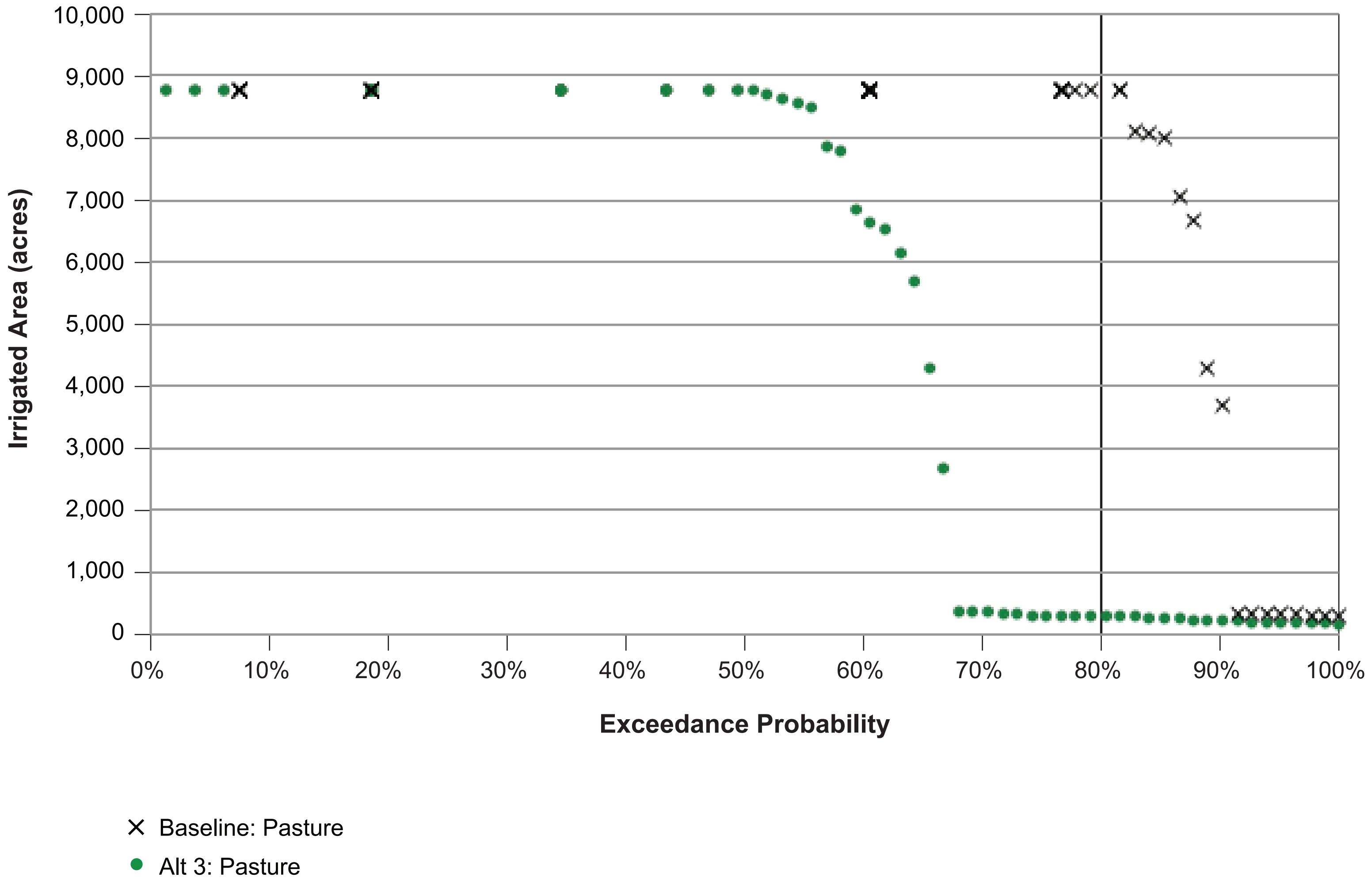

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Figure 11-17f
Irrigated Acreage in MID for Pasture under Alternative 3

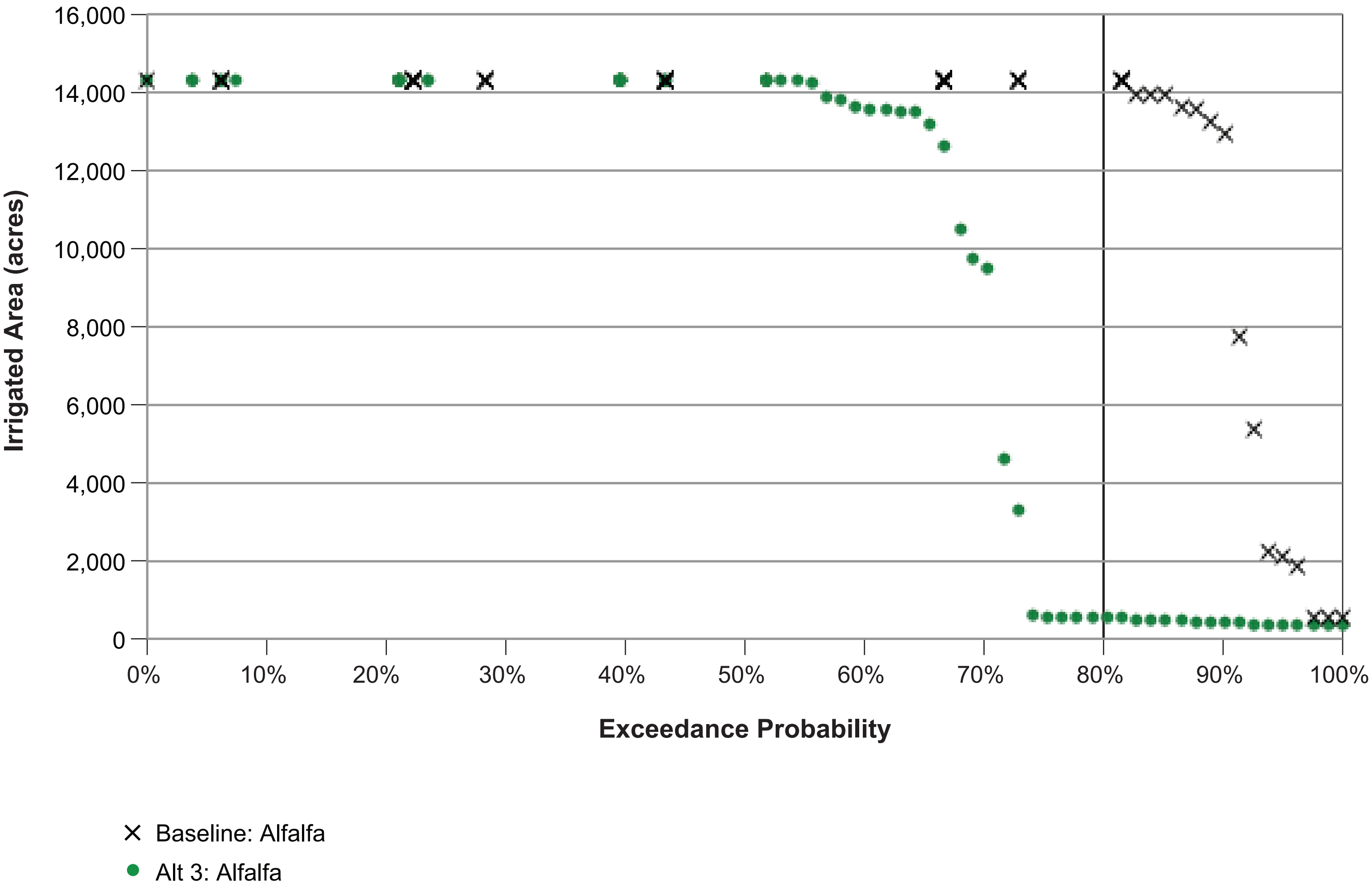

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Figure 11-18a
Irrigated Acreage in TID for Alfalfa under Alternative 3

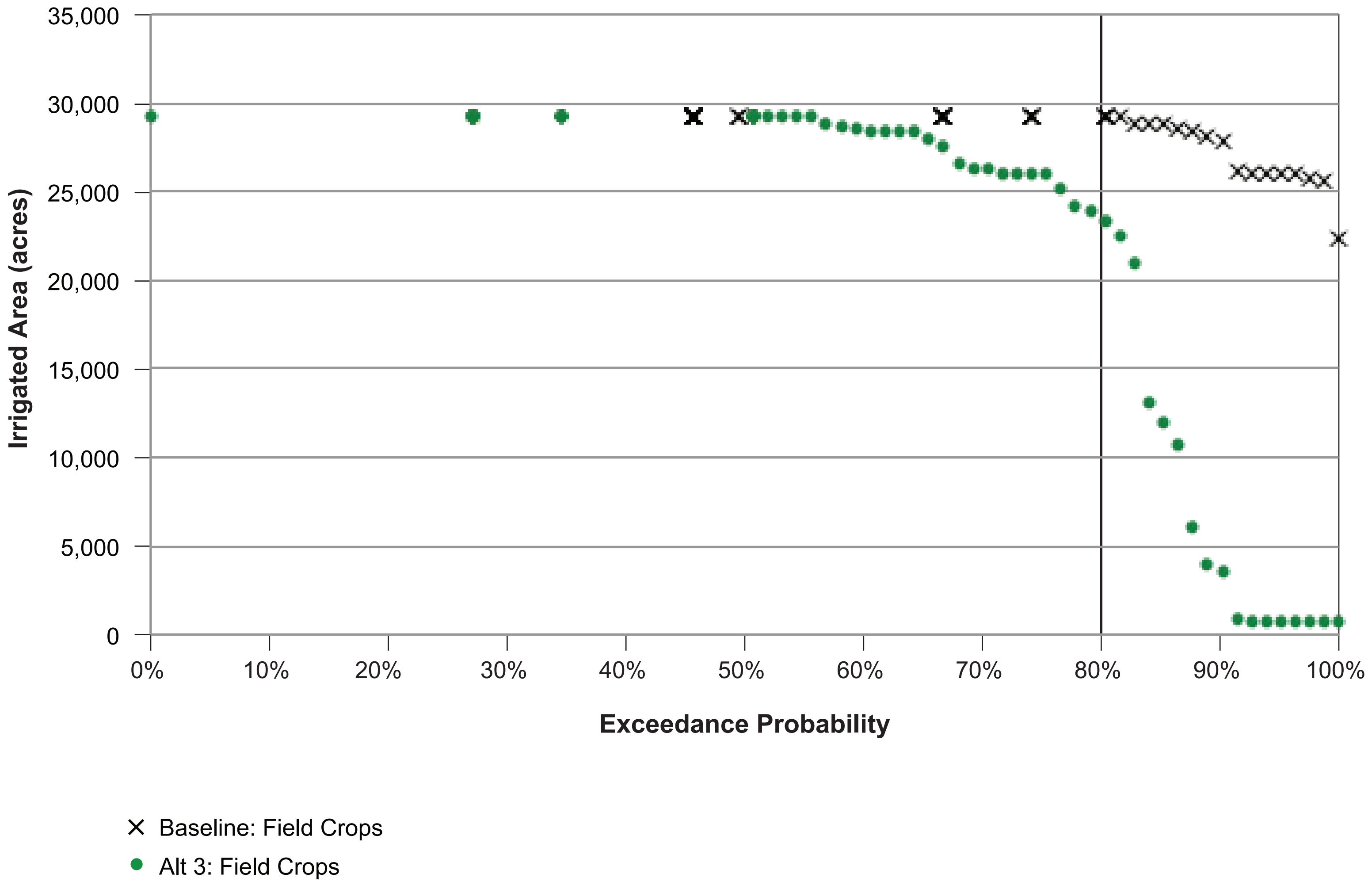

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Figure 11-18b
Irrigated Acreage in TID for Field Crops under Alternative 3

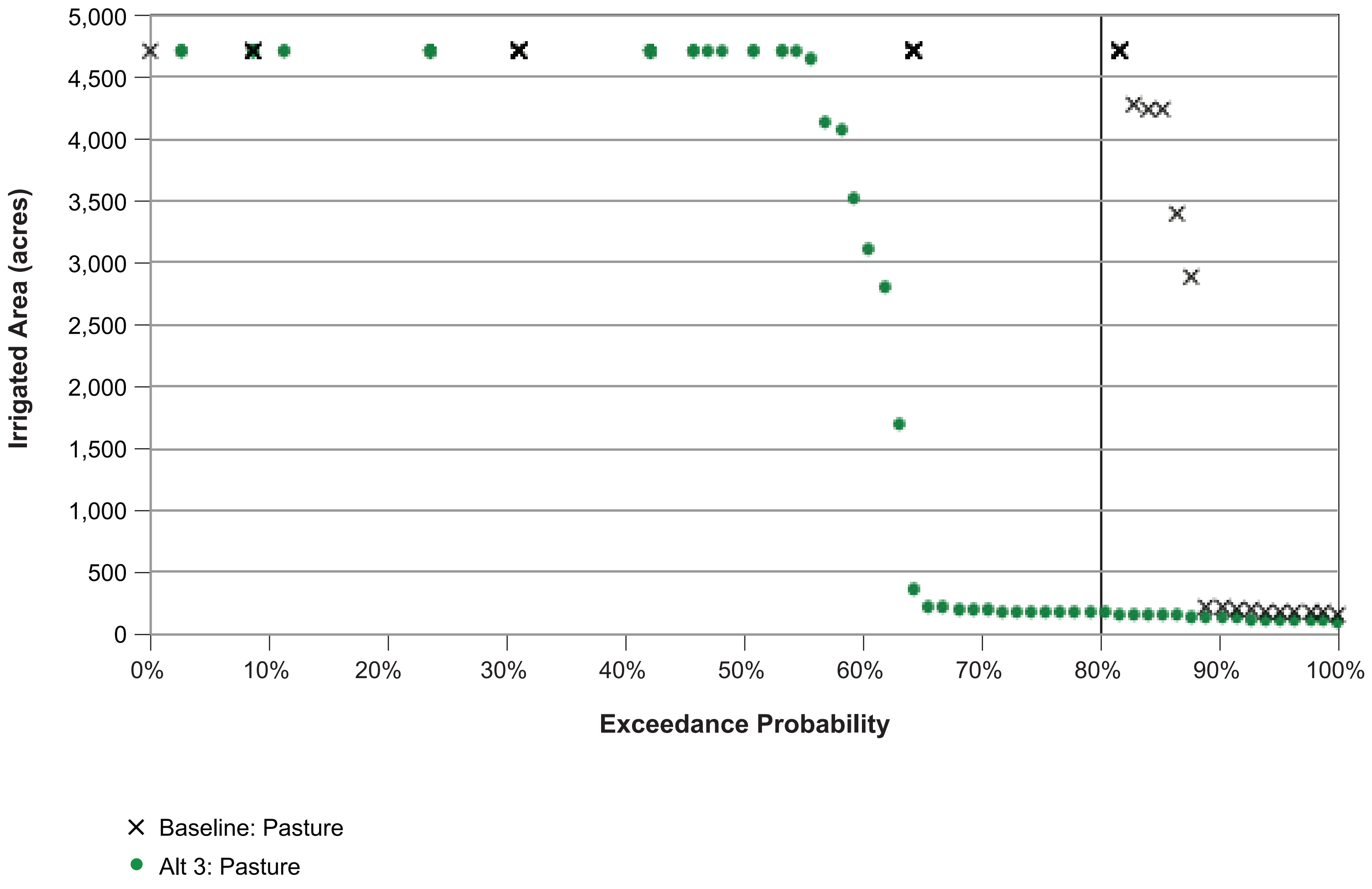

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Figure 11-18c
Irrigated Acreage in TID for Pasture under Alternative 3

regional groundwater agencies, irrigation districts, and local agencies can and should adopt irrigation efficiencies described in LSJR Alternative 2 and local land use authorities can and should impose development conditions and require conservation easements where allowed to mitigate for the loss of agricultural land; however, given the uncertainty of the extent to which these mitigation measures would occur and because they may not fully mitigate impacts, impact would remain significant. While adaptive implementation method 1 could reduce the percent of unimpaired flow to 30 percent and potentially reduce impacts on agricultural resources, it cannot be independently applied as an alternative because it is part of LSJR Alternative 3 and because the purpose of adaptive implementation is to benefit fish. Therefore, according to the number of acres that would no longer be considered Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as predicted by the SWAP model, and the possibility of conversion of these acres to nonagricultural land uses, impacts on agricultural resources would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on agricultural resources. Adaptive implementation method 3 would result in a shift in the volume of February–June water available to other parts of the year, and one potential way to implement this method is included in the modeling results presented for LSJR Alternative 3 in Table 11-17. Because this method would have minimal effect on diversions and the total annual volume of river flow, this method would not affect agricultural resources and it would result in similar impacts to those described above. Adaptive implementation method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40-percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively.

If the adjustment occurs frequently or for extended durations, based on the modeling results for LSJR Alternative 4 and with adaptive implementation method 1 incorporated (i.e., 50 percent unimpaired flow), impacts would still be significant. If the adjustment occurs frequently or for extended durations, based on the modeling results for LSJR Alternative 2 and with adaptive implementation method 1 incorporated (i.e., 30 percent unimpaired flow), impacts on agricultural resources would be less than significant for all districts except for OID, which would experience an average decrease in irrigated acreage of 4.4 percent; and, MID, which would experience an average reduction in irrigated acres of 4.5 percent (Table 11-16) from baseline.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

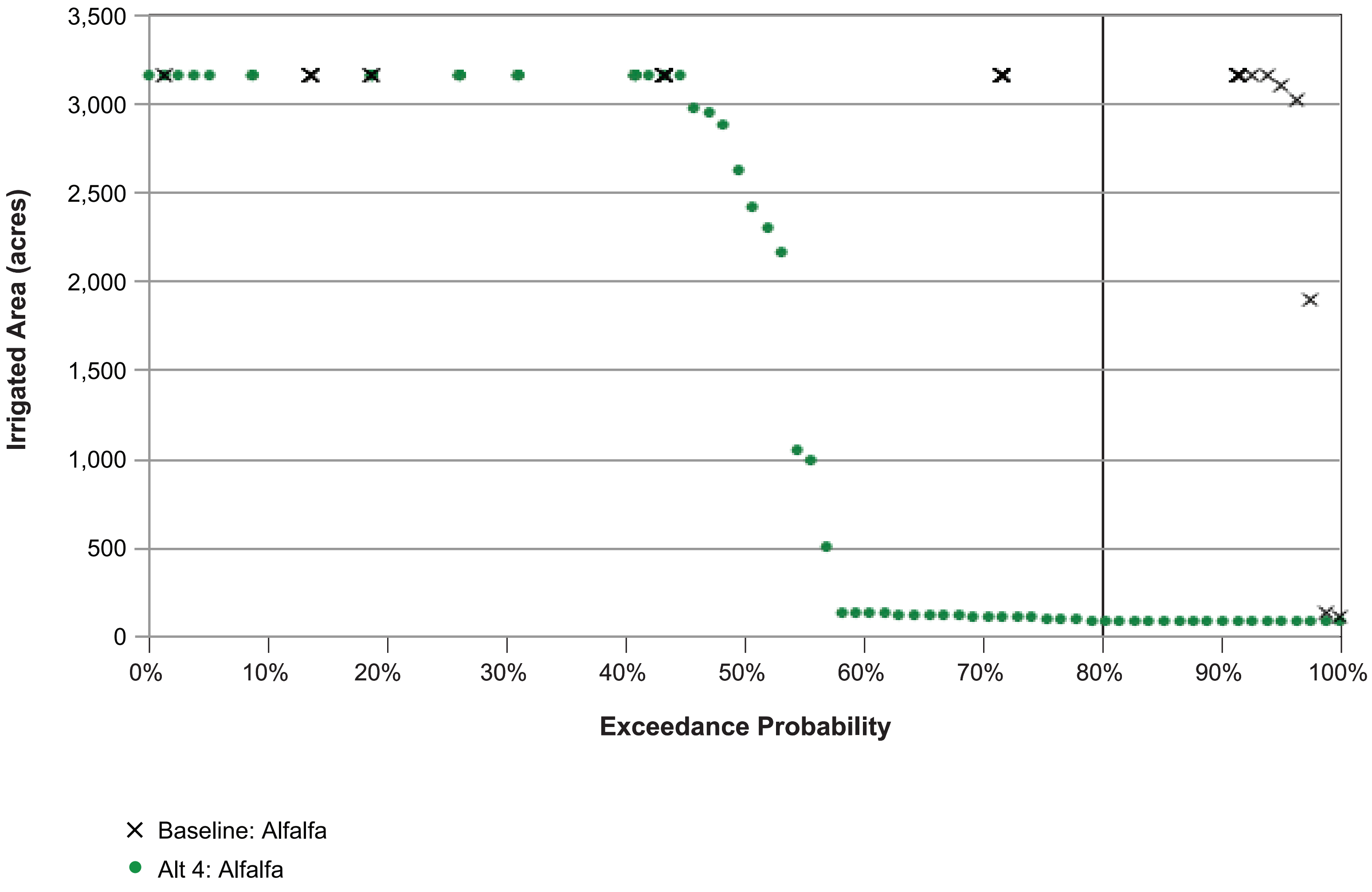
Under Alternative 4, the average annual reduction in acreage ranges from a low of 0 percent for SEWD and CSJWCD to 27.5 percent for MID (Table 11-19). Figures 11-19 through 11-22 show SWAP-modeled crop changes for all crops as a result of LSJR Alternative 4 compared to baseline for the six geographic areas. While the SWAP results indicated there would be little to no change in crop acreage for either SEWD/CSJWCD or Merced ID, the remaining irrigation districts are predicted to experience change in crop acreage for various crop categories. Crops categories that would experience an average acreage reduction of greater than 4 percent are shown in Figures 11-19 through 11-22 for SSJID, OID, MID, and TID respectively. These figures show how the acreage of select crops change in response to reduced water availability under both baseline and LSJR Alternative 4. Figure 11-19a, for example, shows the irrigated acreage in SSJID for Alfalfa. Under baseline, acreage remains stable, at approximately 3,200 acres, in a little over 95 percent of all years, and then is reduced to less than 200 acres. This is reflective of the response to reduced water availability that occurs about once in every 20 years under baseline. Acreage also remains stable under LSJR Alternative 4 in approximately 45 percent of years, but then is reduced to about 200 acres or less in approximately 42 percent of years. These figures show how the average reductions in crop acreages are concentrated in years with reduced water availability, and vary depending on crop type. Figures are not shown for crops that are not much affected by reduced water supplies, such as Orchards, Vines, and Truck crops (see Appendix G, Tables G.4-6a through G.4-6f).

Table 11-19. Average Cropped Acreage and Acreage Reduction under LSJR Alternative 4, by District, Compared to Baseline

	Baseline	LSJR Alternative 4		
District	Average Acres		Acre Change	% Reduction
SSJID	58,229	52,048	-6,181	10.6
OID	54,162	43,414	-10,748	19.8
SEWD + CSJWCD	98,931	98,931	0	0.0
MID	57,354	41,580	-15,774	27.5
TID	143,783	108,490	-35,294	24.5
Merced ID	99,769	97,126	-2,644	2.6
Total	512,229	441,589	-70,640	13.8

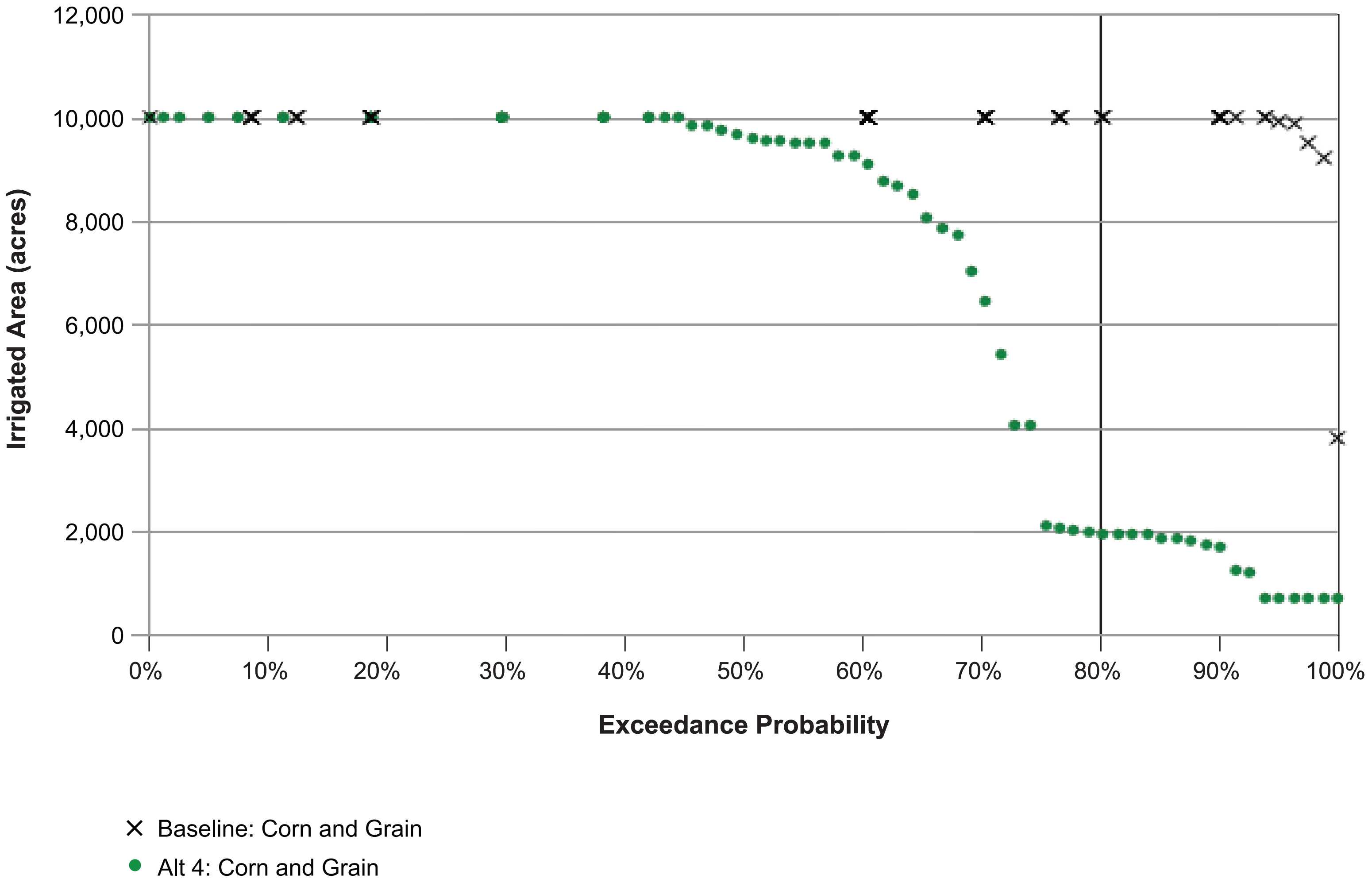
Since the land within the six geographic areas would need irrigation 8 out of 10 years to qualify as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance it is expected the total lands classified as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance would be reduced as a result of LSJR Alternative 4 (Table 11-19). It is unknown whether the reduction in irrigation water would result in a direct conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use, but it is conservative to assume that if irrigation water is unavailable to sustain these acreages identified in Table 11-19, then some of the 70,640 acres affected in SSJID, OID, MID, and TID (17 percent of the total Prime Farmland, Unique Farmland, and Farmland of Statewide Importance within the affected districts) would be converted to nonagricultural uses

When the maximum groundwater pumping capacity for 2014 is used in the analysis instead of the estimates for 2009, the acreage is less affected because there was more groundwater pumping in 2014 to meet the shortfall in the applied surface water needed to meet crop demand. The results show an overall decrease in the reduction of average annual crop acreage for all irrigation districts, but particularly MID (Table 11-20). If the groundwater pumping capabilities of the irrigation districts are closer to the 2014 values, then the crop acreage reductions estimated under 2009 conditions would be smaller; however, it is unlikely this is a sustainable practice given groundwater conditions (Chapter 9, *Groundwater Resources)*.



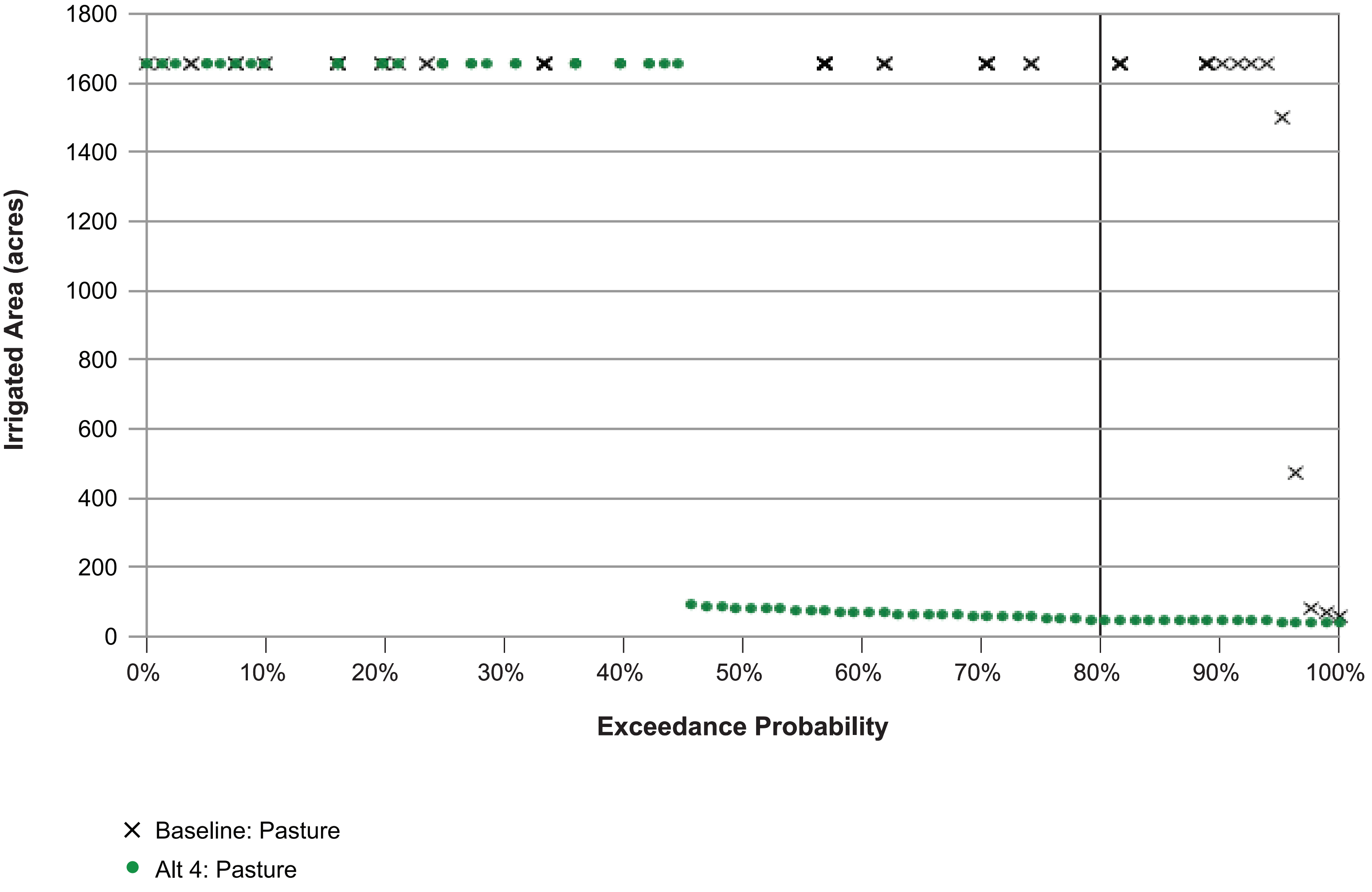
Graphics...00427.11 (1-8-2016)

Figure 11-19a
Irrigated Acreage in SSJID for Alfalfa under Alternative 4



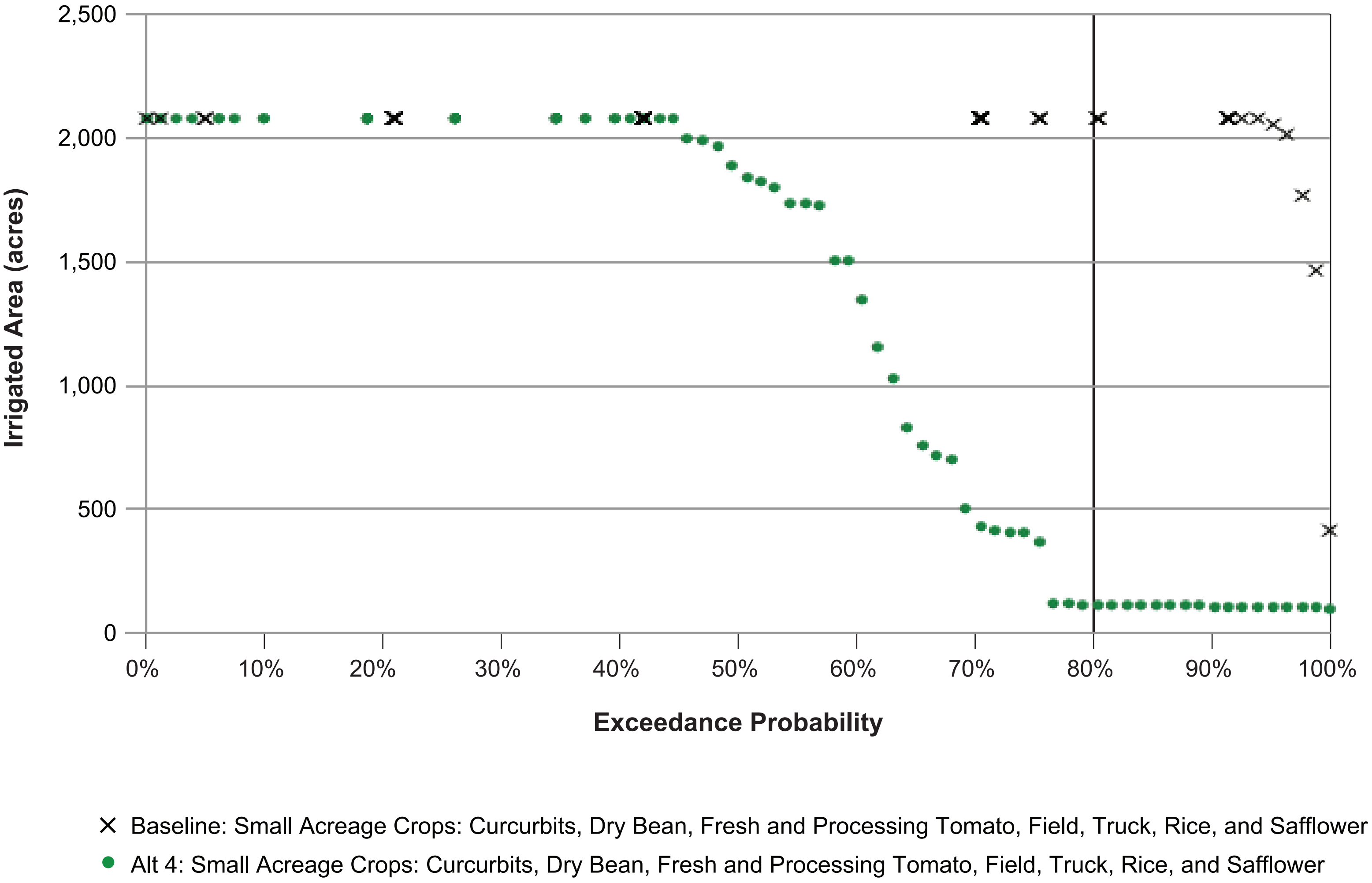
Graphics...00427.11 (1-8-2016)

Figure 11-19b
Irrigated Acreage in SSJID for Corn and Grain under Alternative 4



Graphics...00427.11 (1-8-2016)

Figure 11-19c
Irrigated Acreage in SSJID for Pasture under Alternative 4



Graphics...00427.11 (1-8-2016)

Figure 11-19d
Irrigated Acreage in SSJID for Small Acreage Crops under Alternative 4

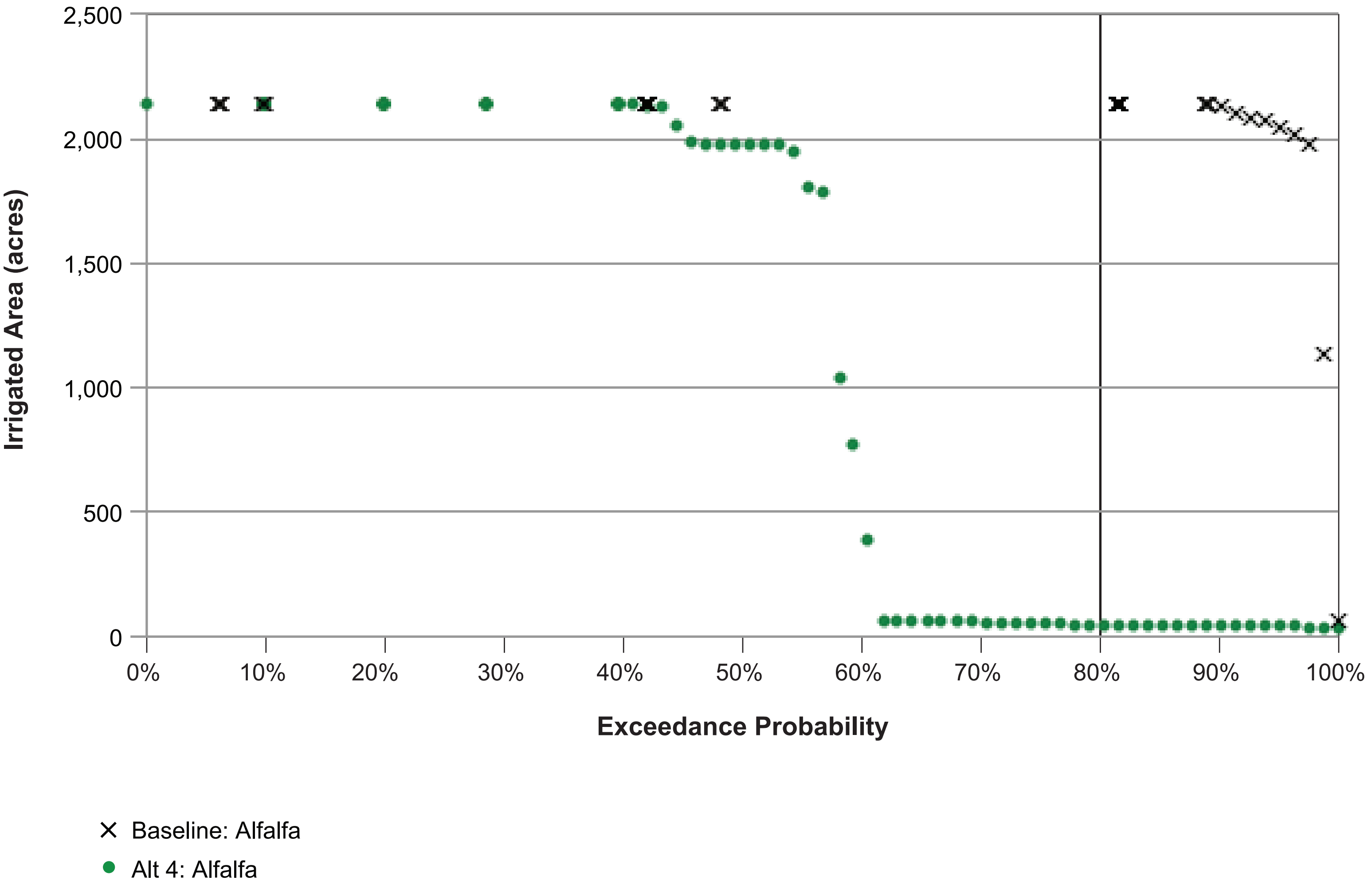


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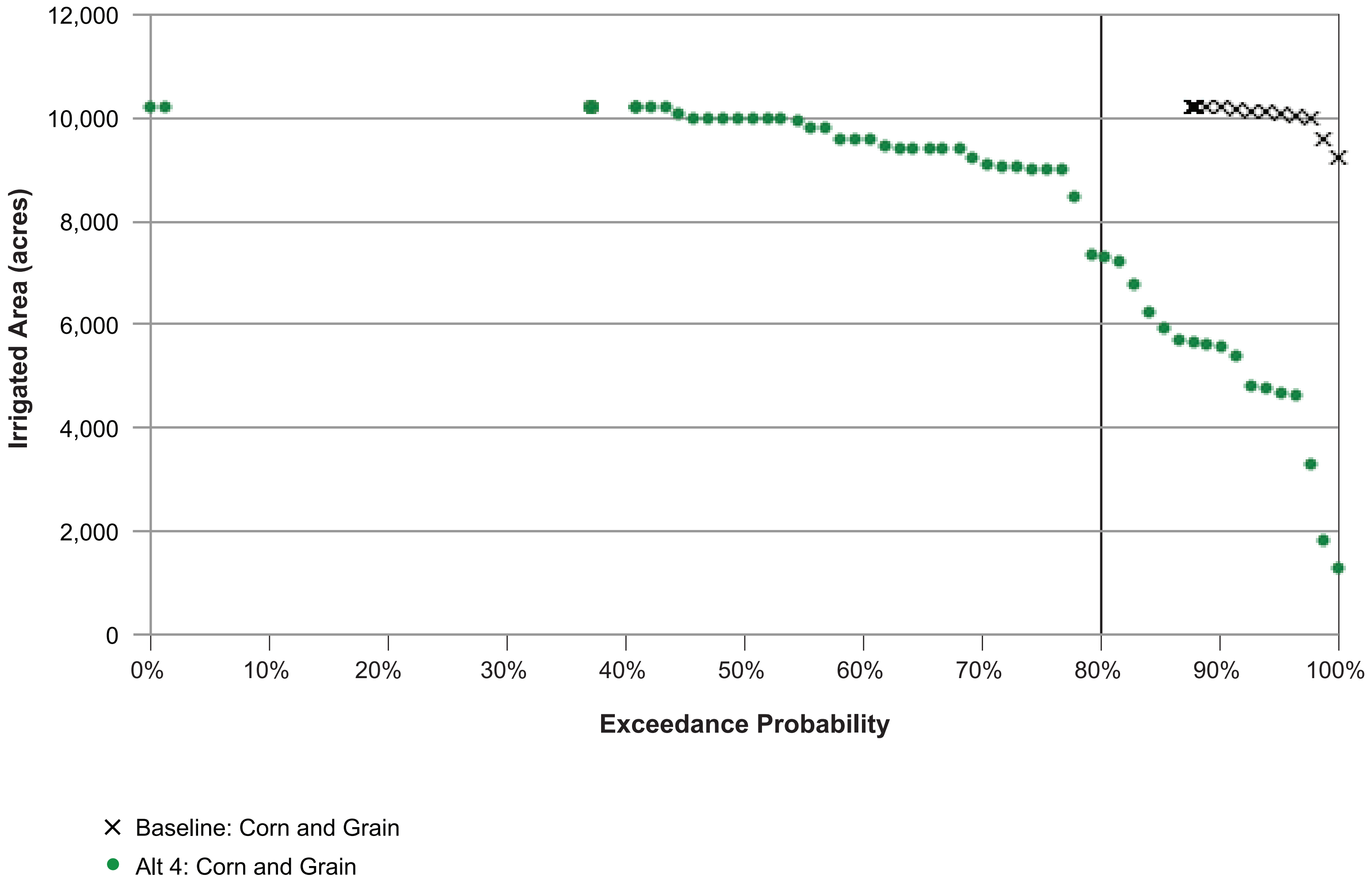
Figure 11-20a
Irrigated Acreage in OID for Alfalfa under Alternative 4



Graphics...00427.11 (1-8-2016)

Figure 11-20b
Irrigated Acreage in OID for Corn and Grain under Alternative 4

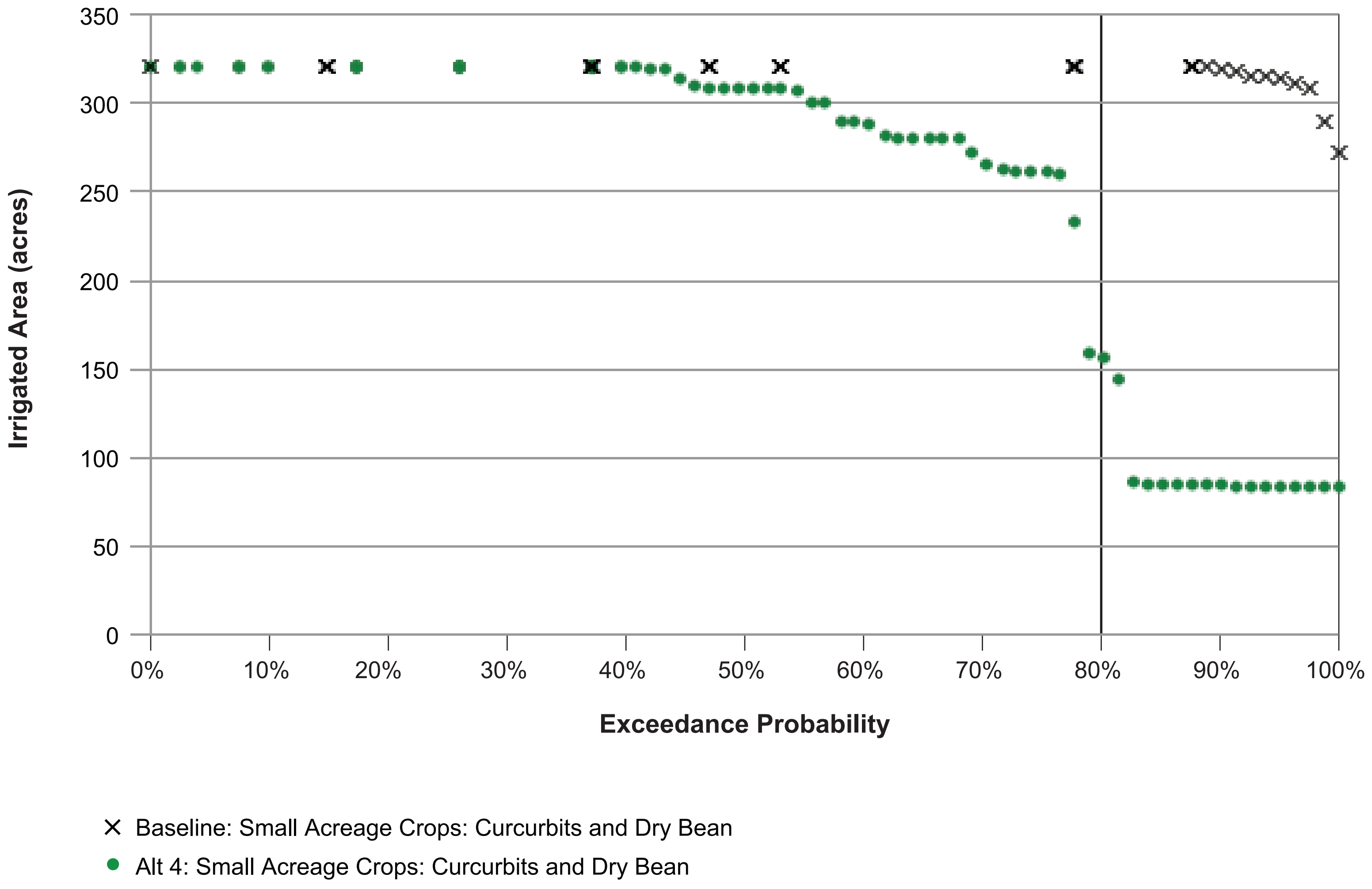


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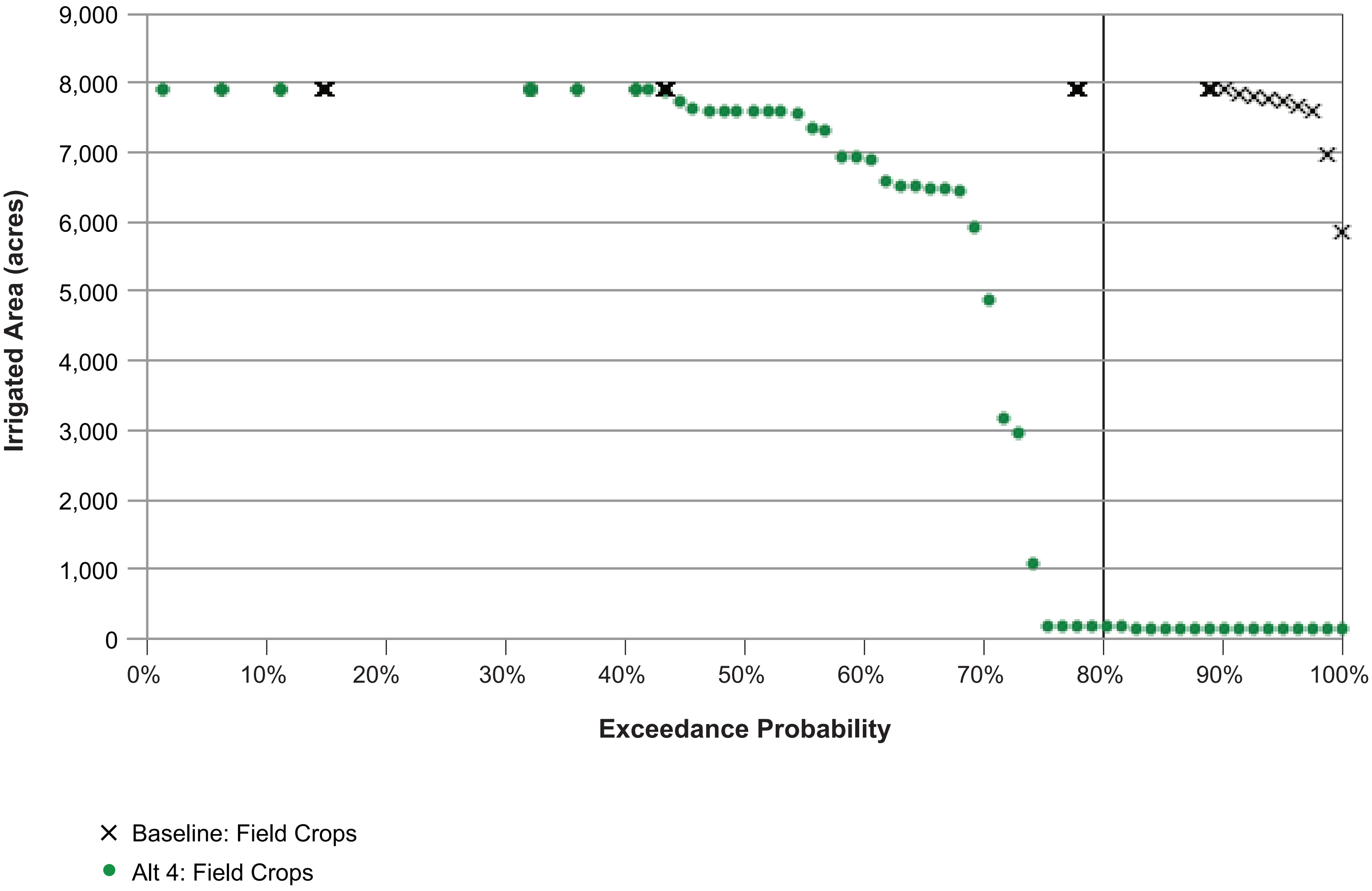
Figure 11-20c

Irrigated Acreage in OID for Small Acreage Crops under Alternative 4



Graphics...00427.11 (1-8-2016)

Figure 11-20d
Irrigated Acreage in OID for Field Crops under Alternative 4

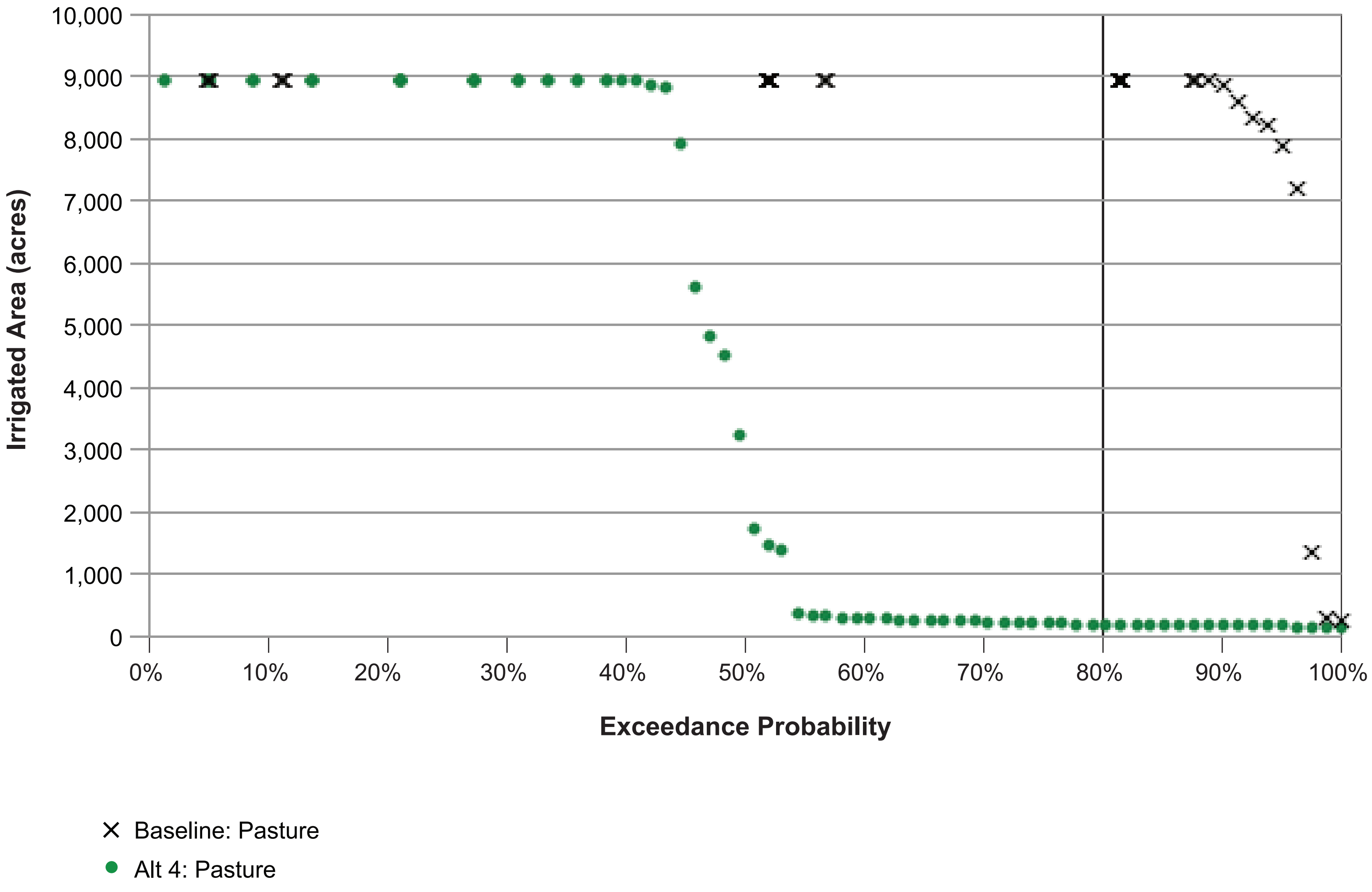


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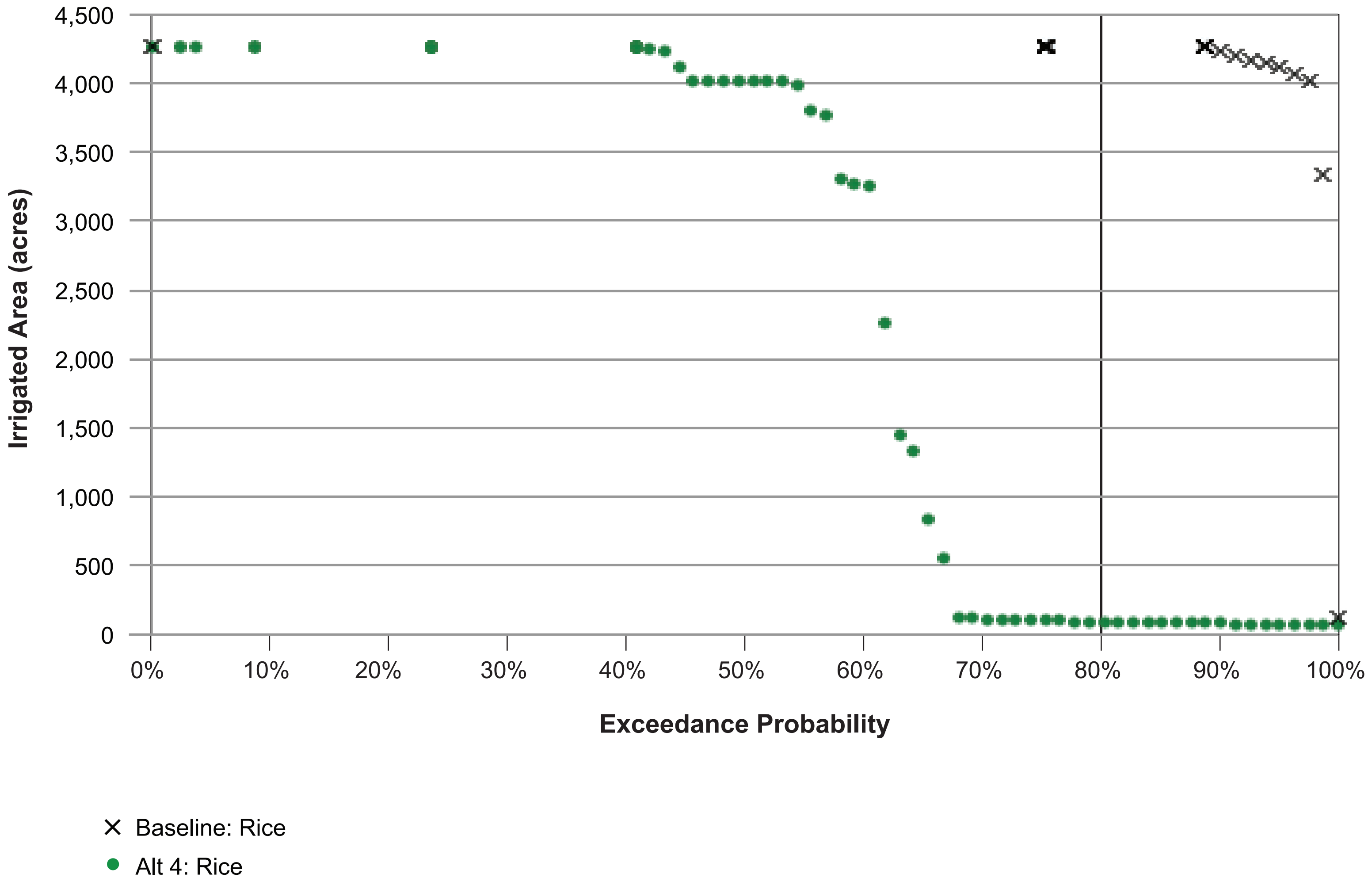
Figure 11-20e
Irrigated Acreage in OID for Pasture under Alternative 4



Graphics...00427.11 (1-8-2016)

Figure 11-20f
Irrigated Acreage in OID for Rice under Alternative 4

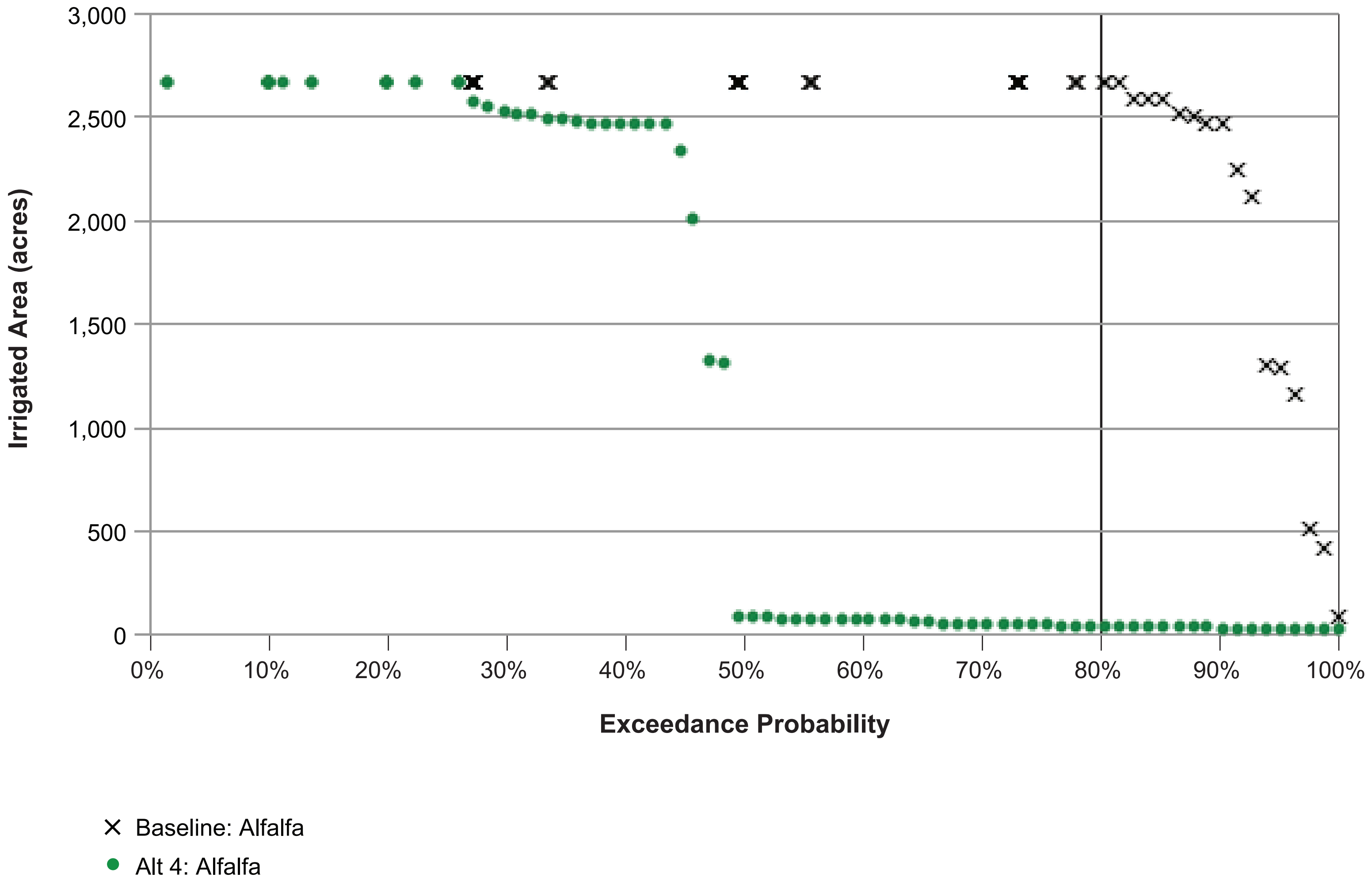
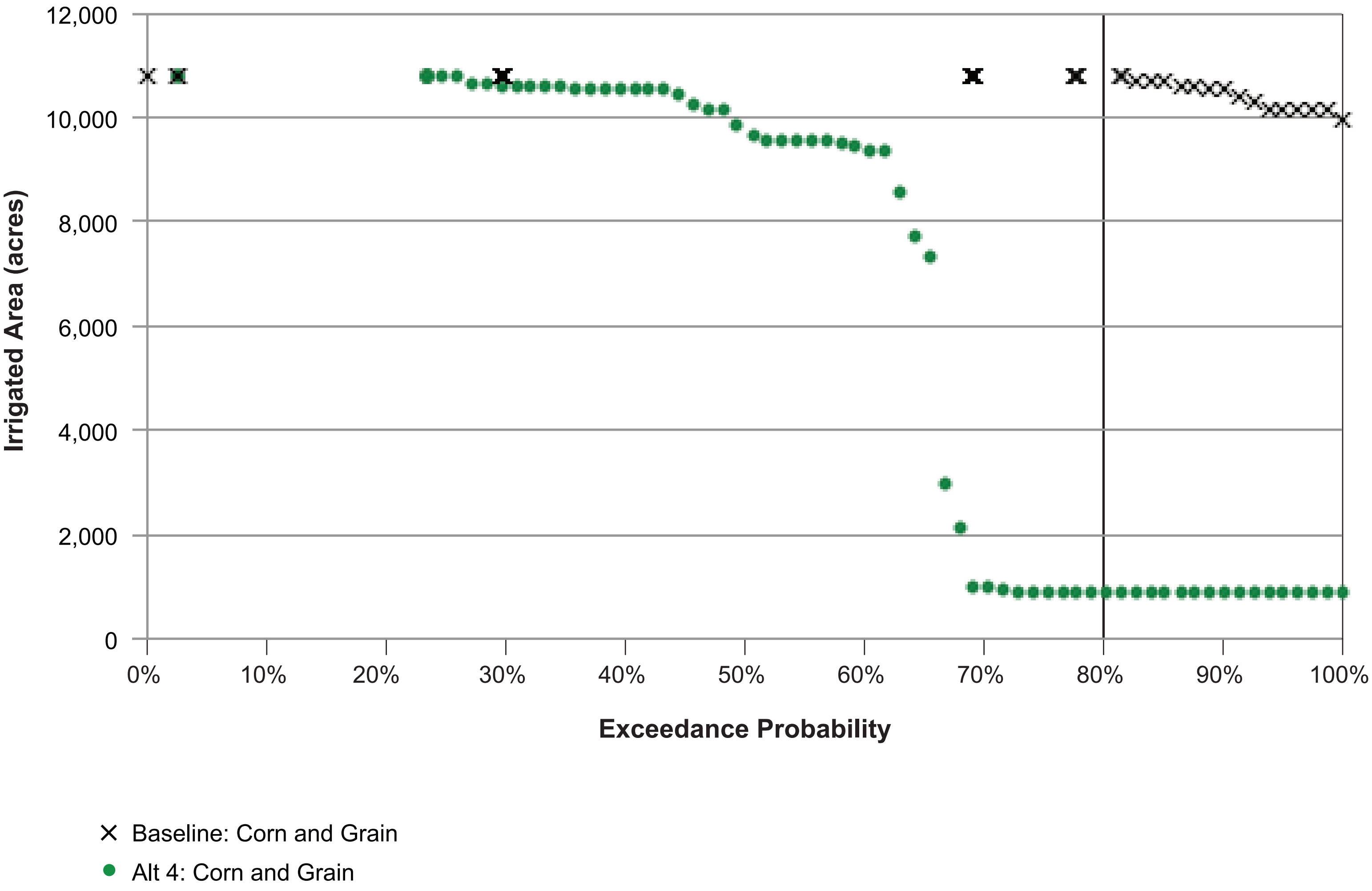


Figure 11-21a
Irrigated Acreage in MID for Alfalfa under Alternative 4



Graphics...00427.11 (1-11-2016)

Figure 11-21b
Irrigated Acreage in MID for Corn and Grain under Alternative 4

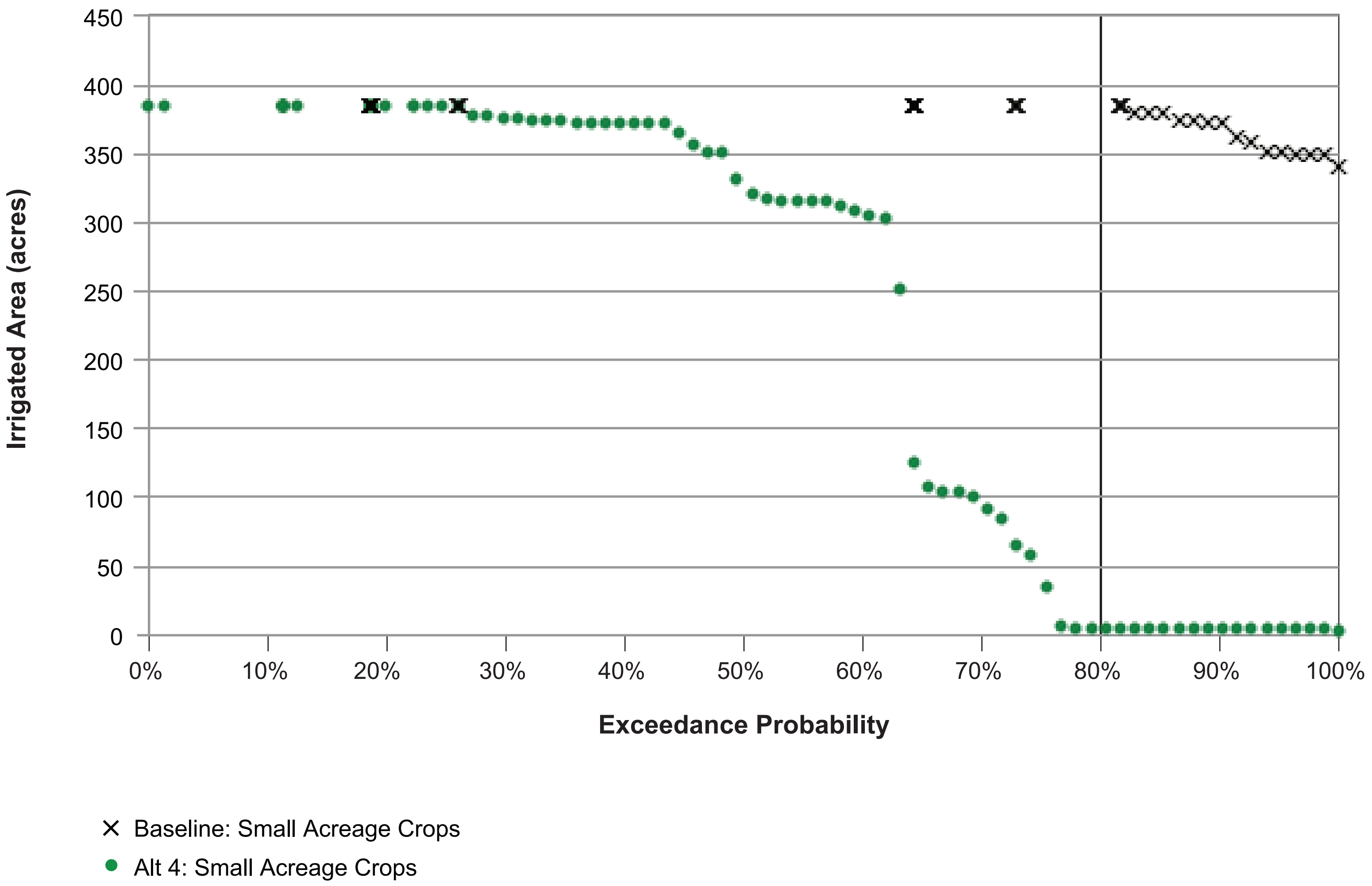


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Figure 11-21c
Irrigated Acreage in MID for Small Acreage Crops under Alternative 4

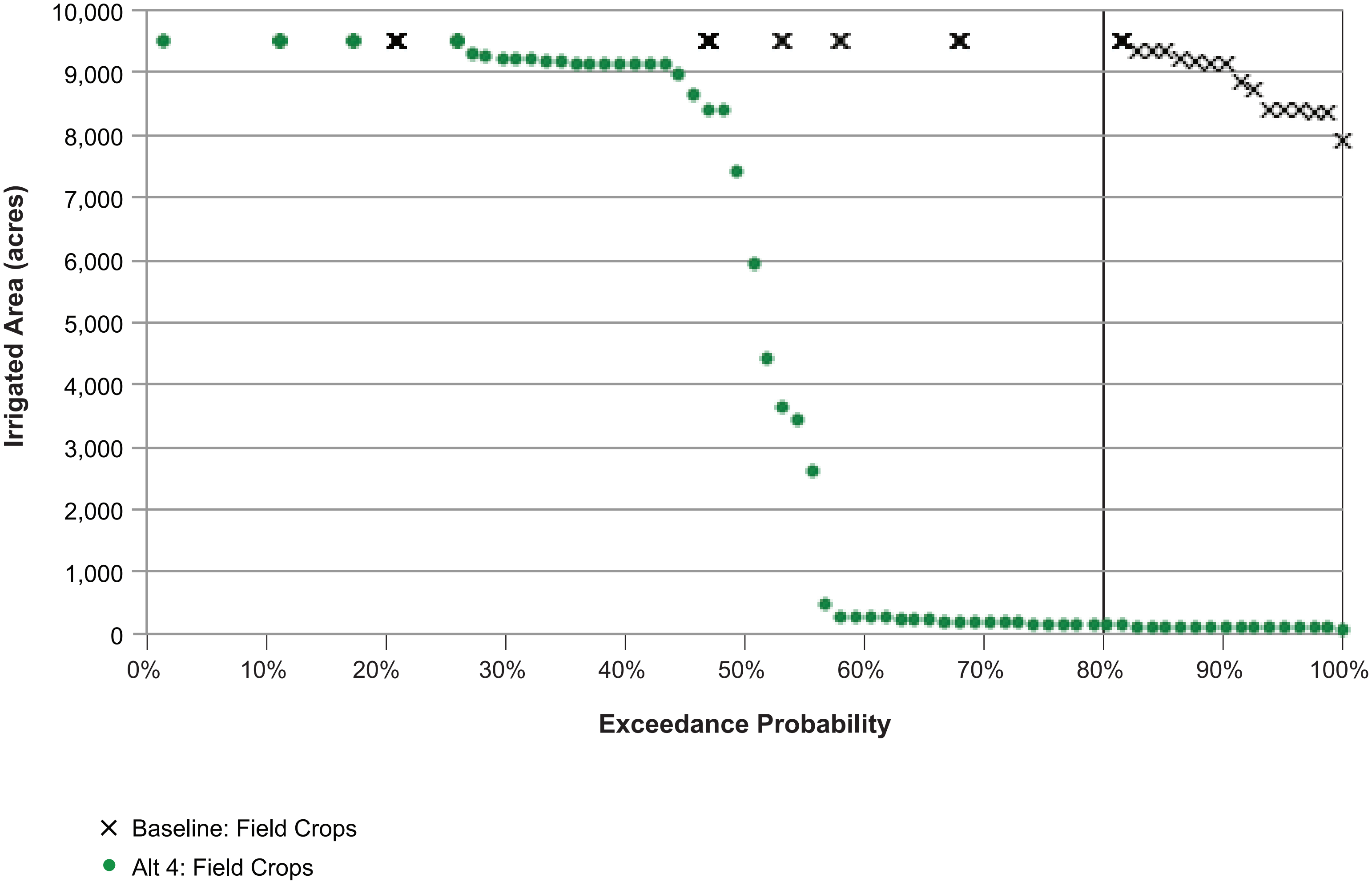

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Figure 11-21d
Irrigated Acreage in MID for Field Crops under Alternative 4

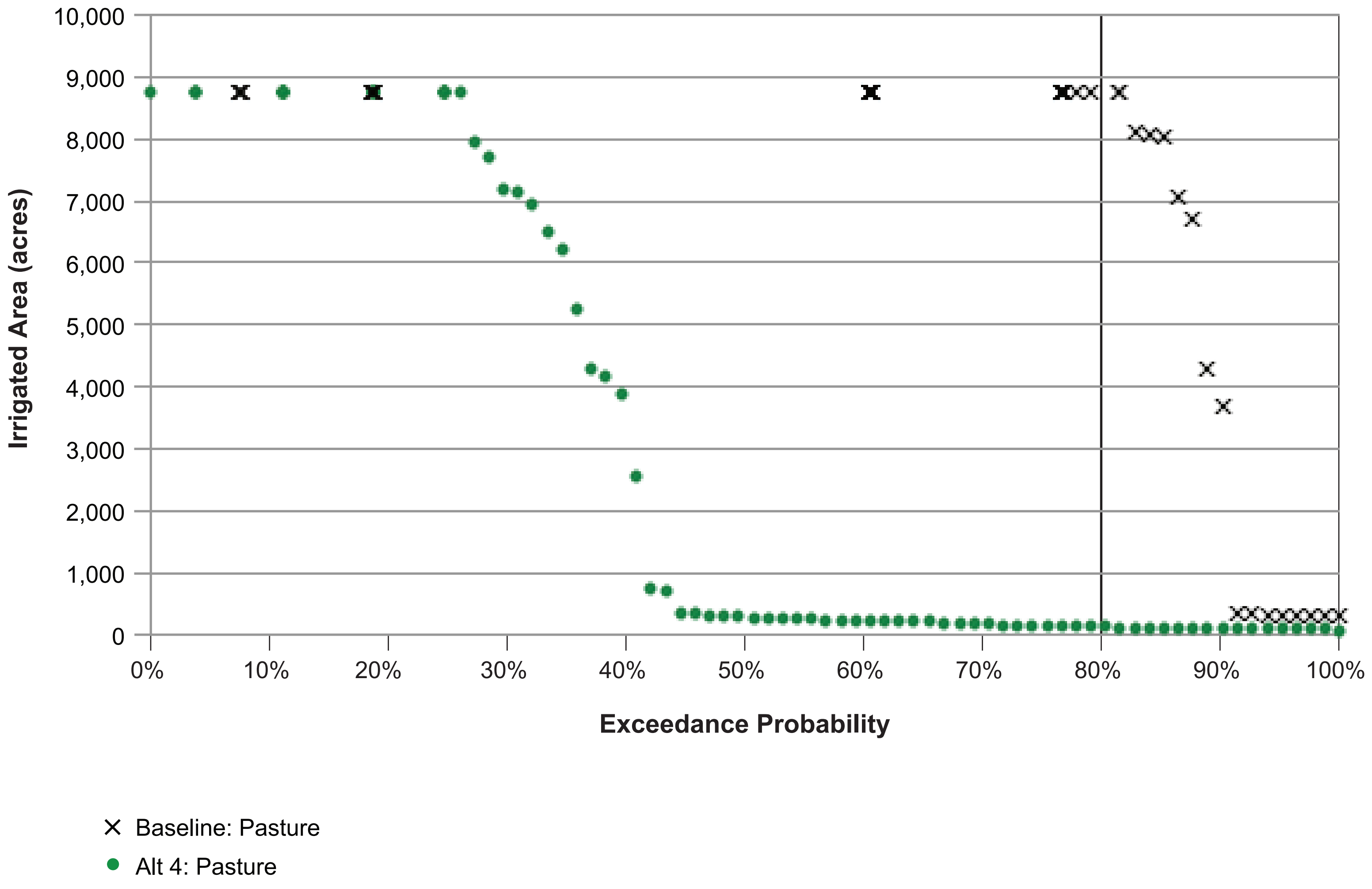

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Figure 11-21e
Irrigated Acreage in MID for Pasture under Alternative 4

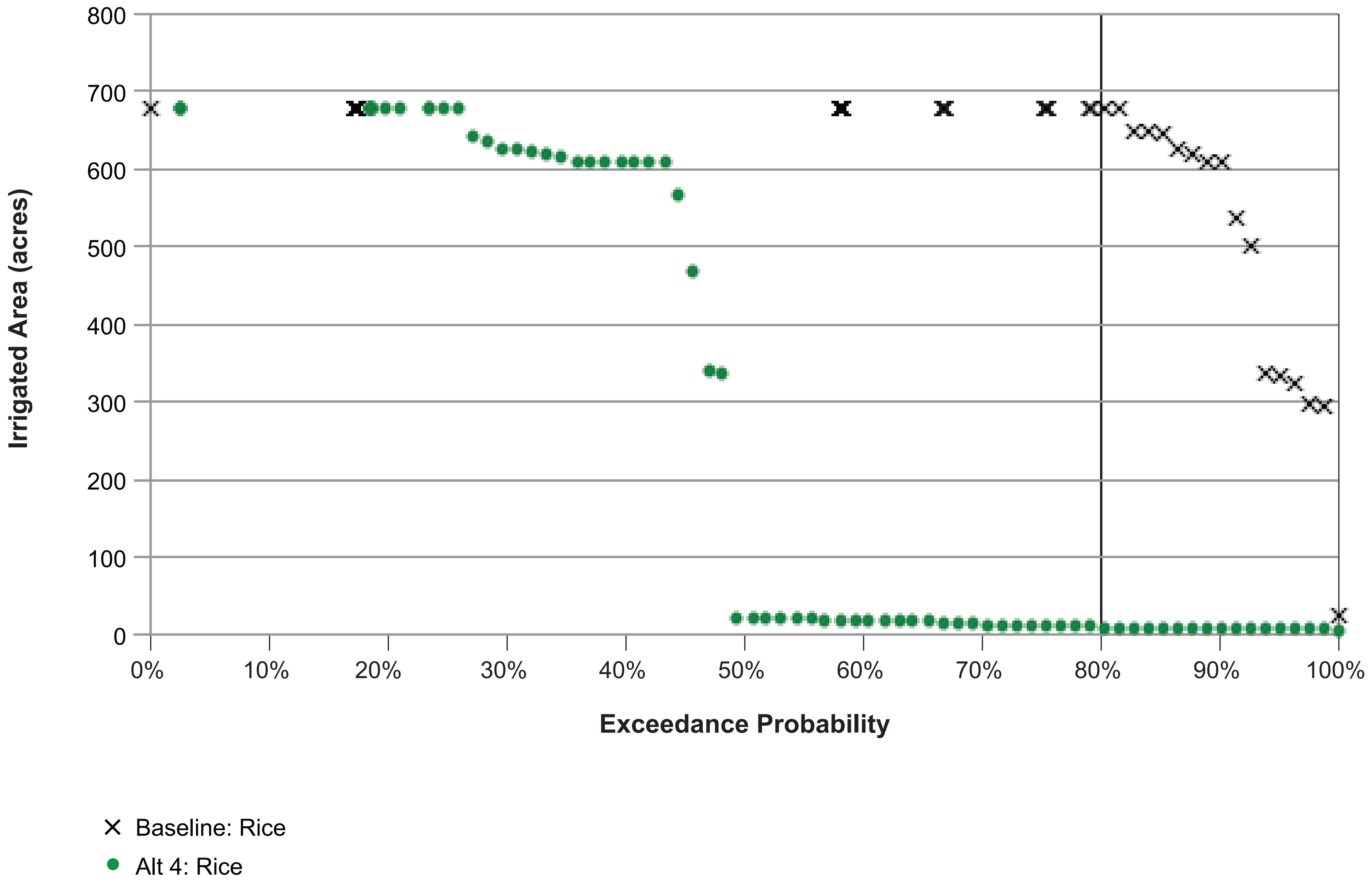

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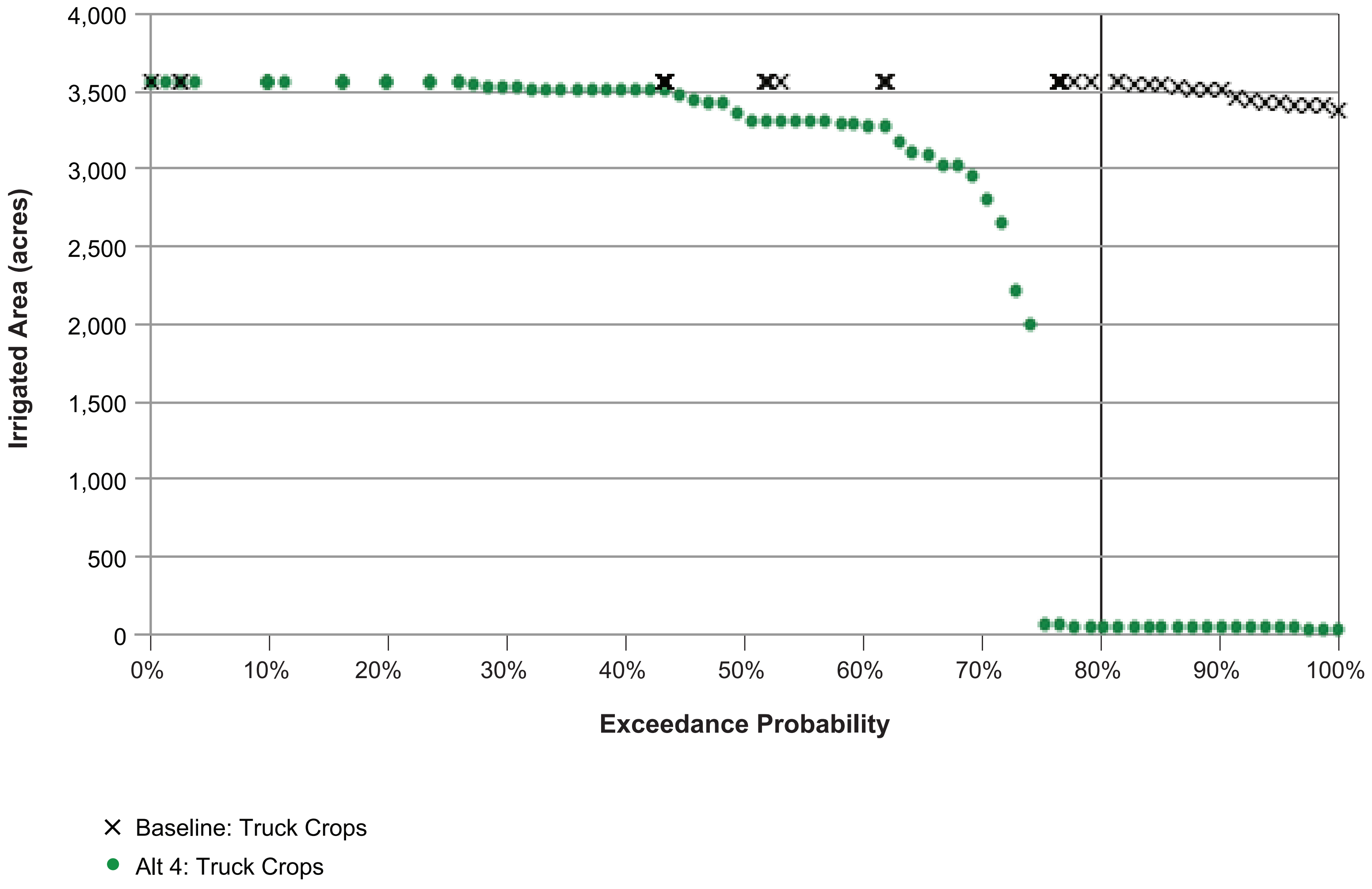
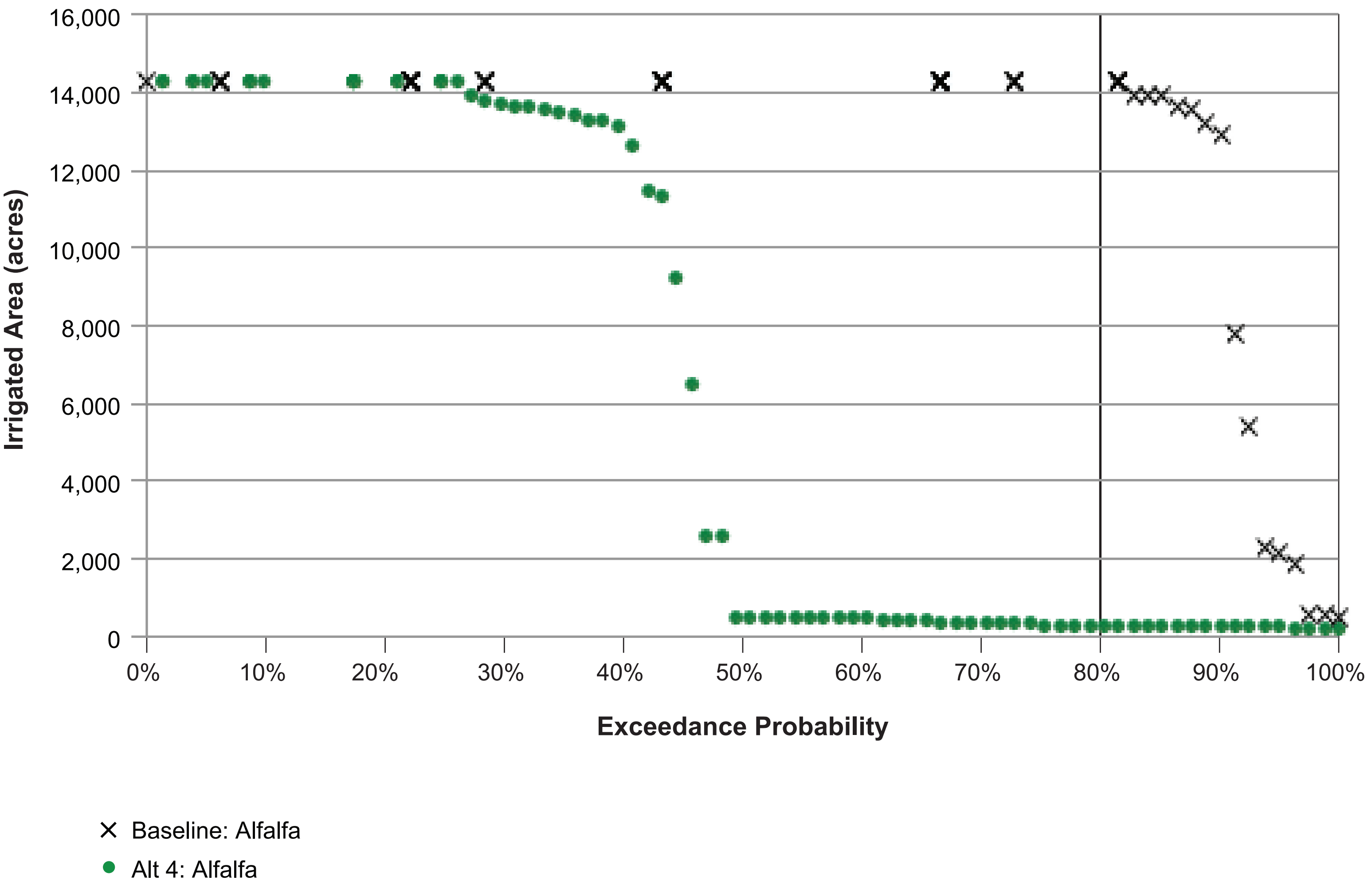
Figure 11-21f
Irrigated Acreage in MID for Rice under Alternative 4



Graphics...00427.11 (1-11-2016)

Figure 11-21g
Irrigated Acreage in MID for Truck Crops under Alternative 4



Graphics...00427.11 (1-11-2016)

Figure 11-22a
Irrigated Acreage in TID for Alfalfa under Alternative 4

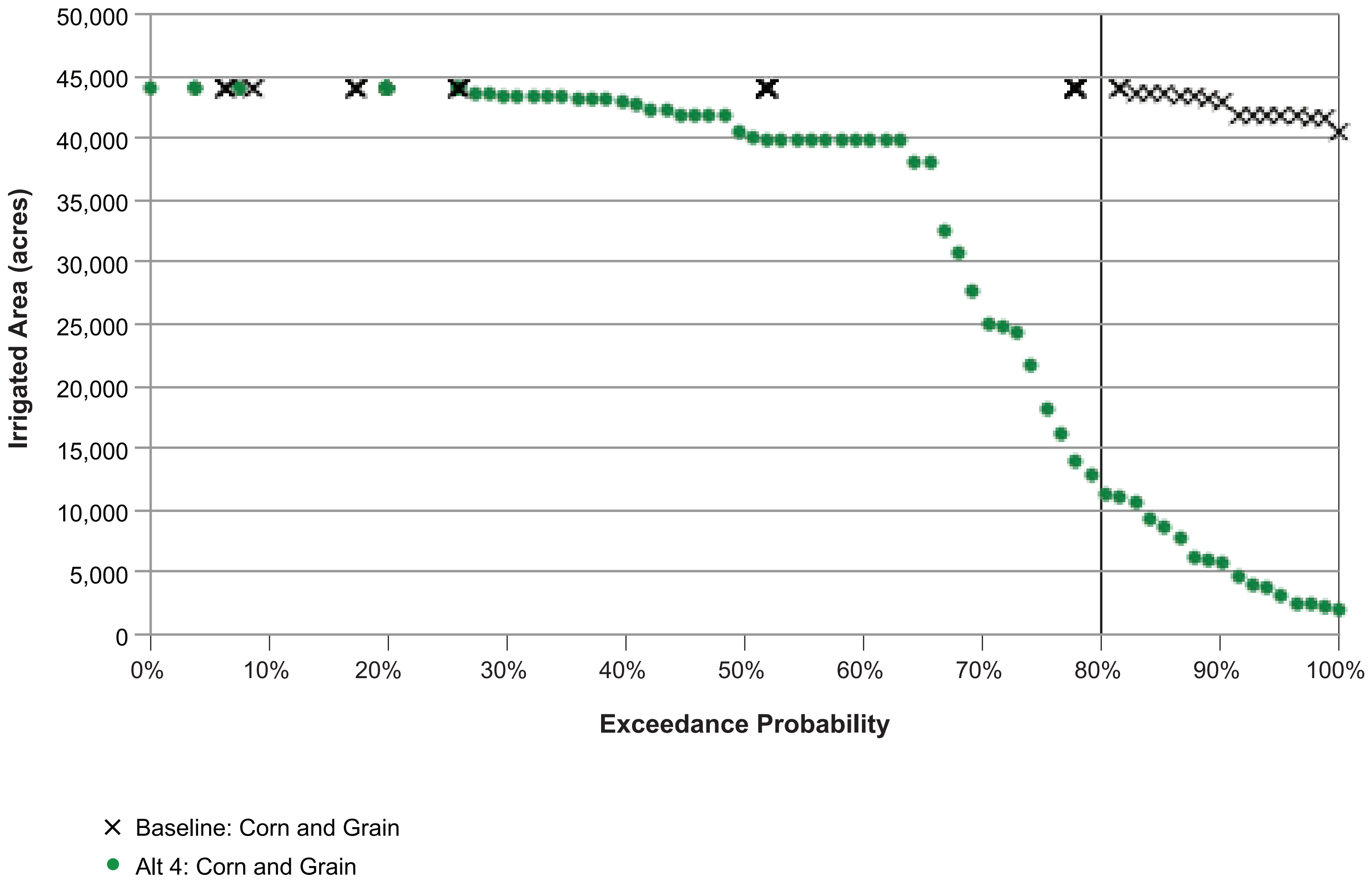


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Figure 11-22b
Irrigated Acreage in TID for Corn and Grain under Alternative 4

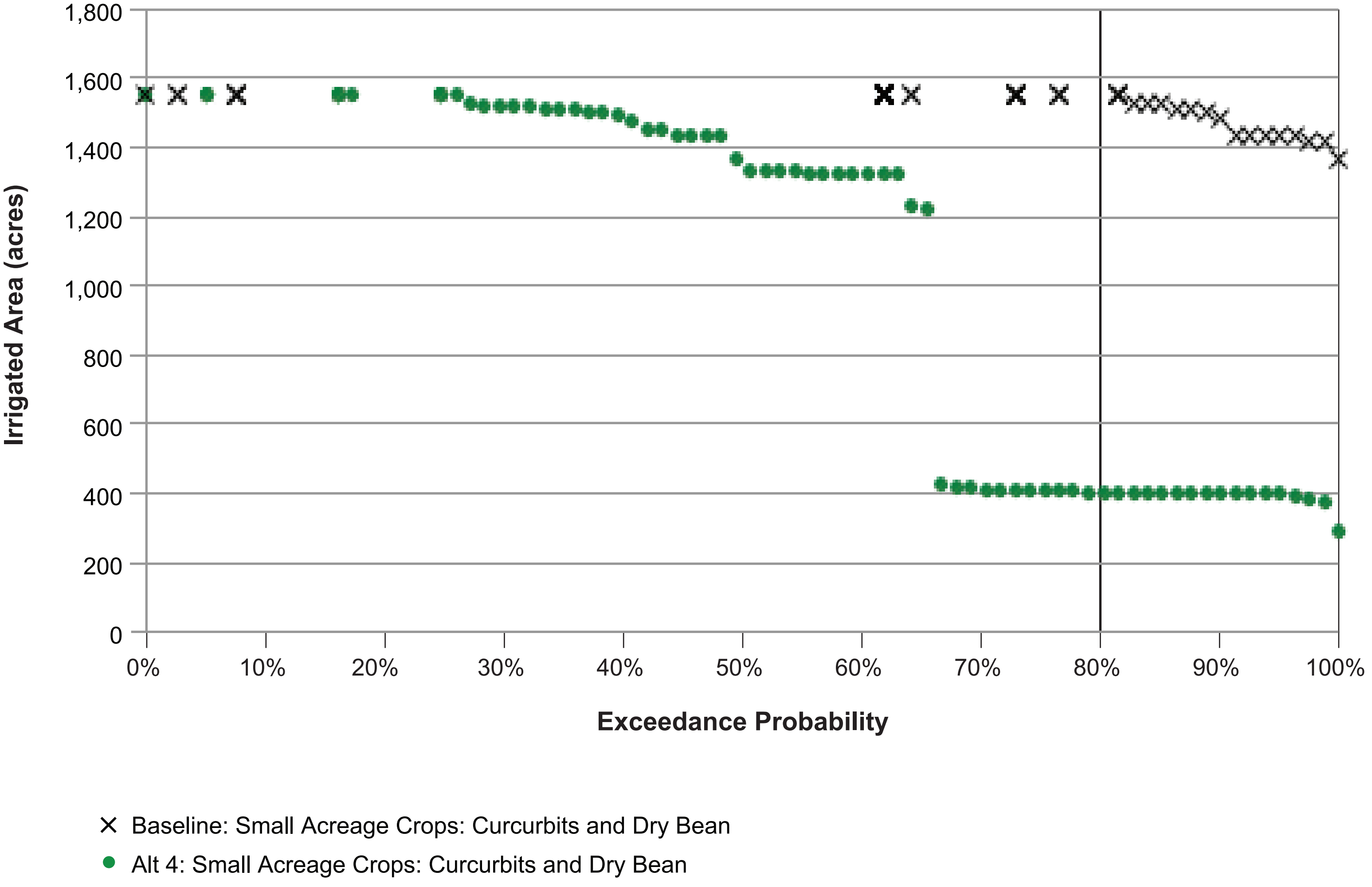

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Figure 11-22c
Irrigated Acreage in TID for Small Acreage Crops under Alternative 4

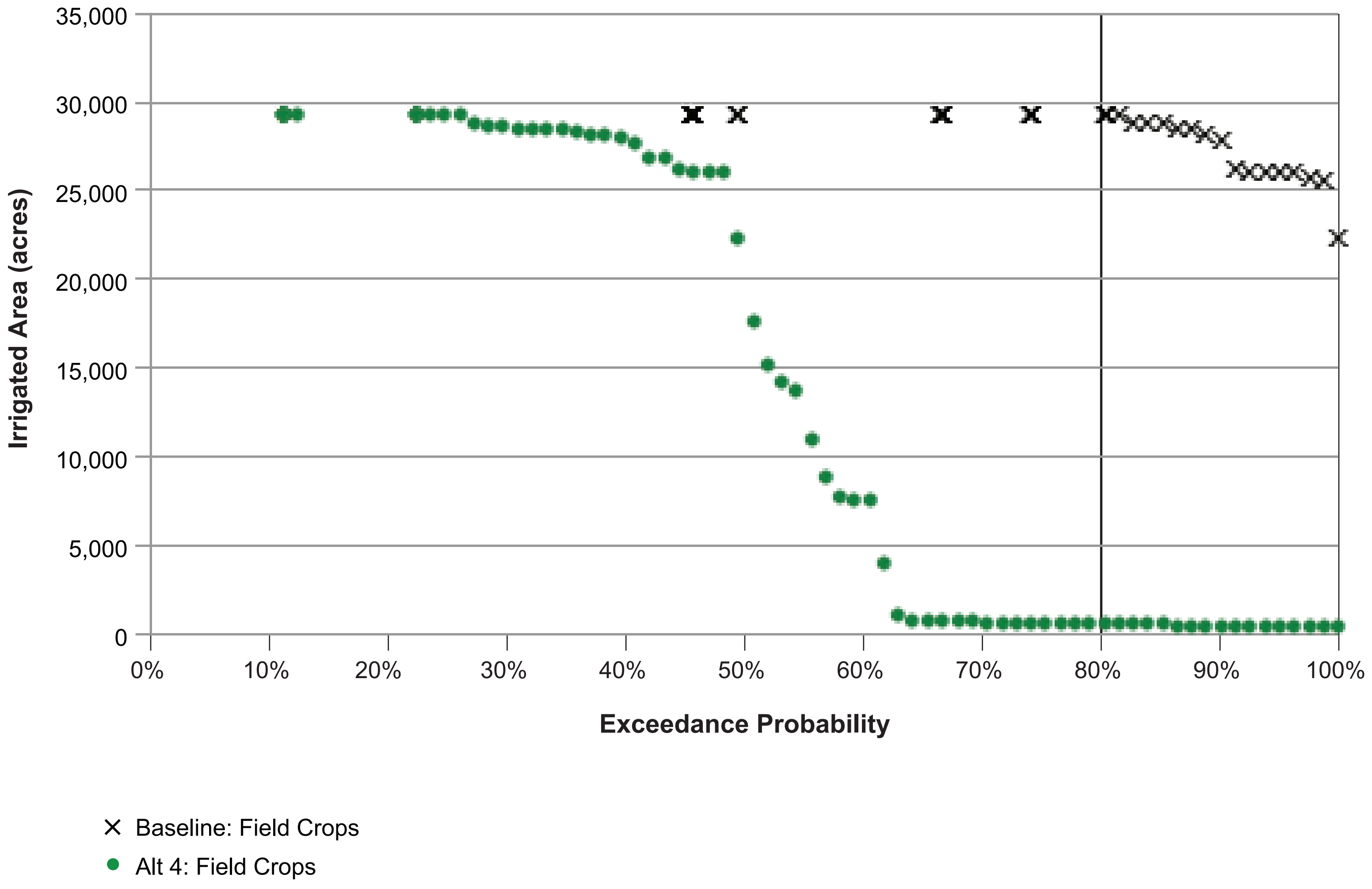

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Figure 11-22d
Irrigated Acreage in TID for Field Crops under Alternative 4

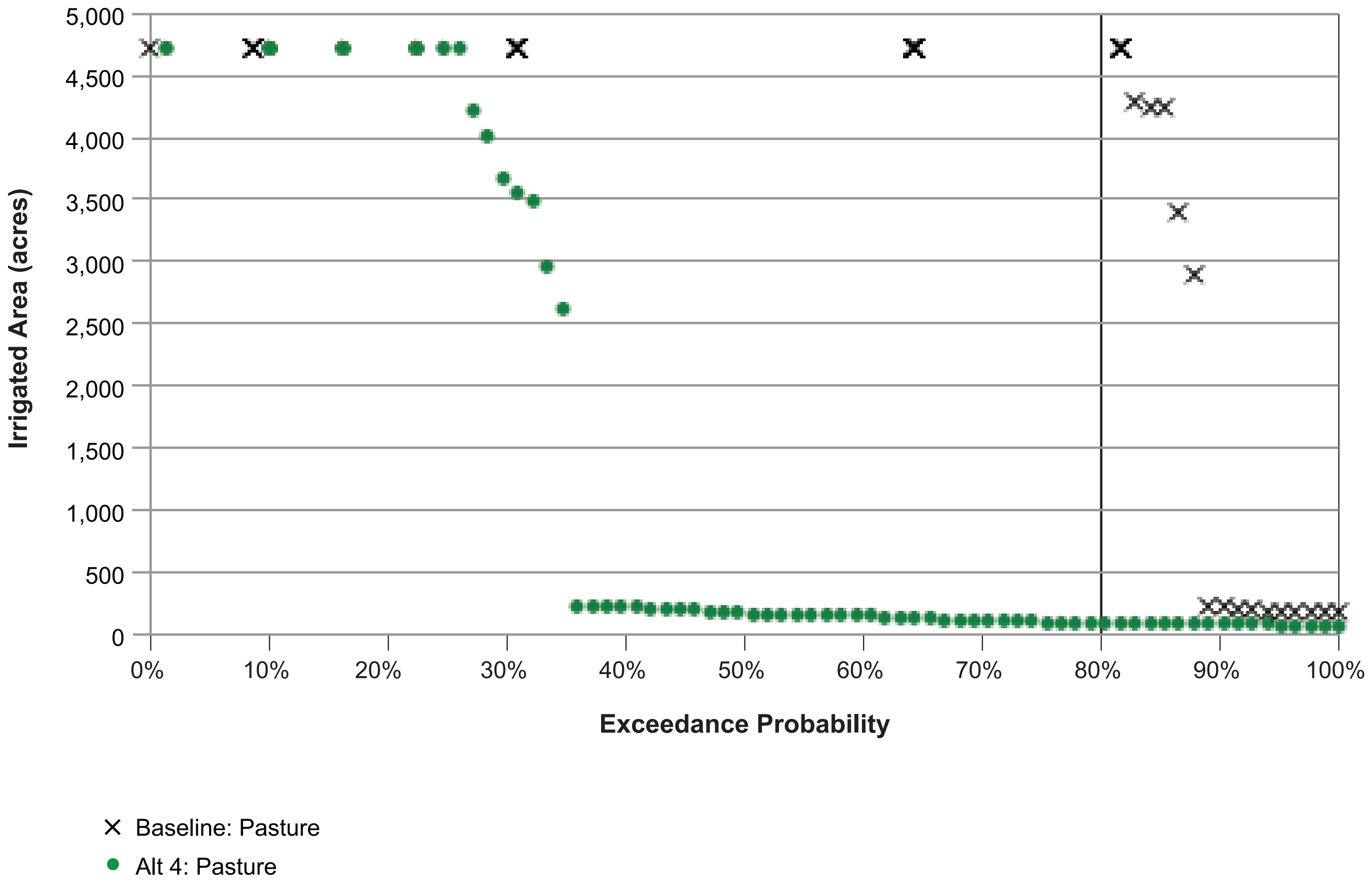

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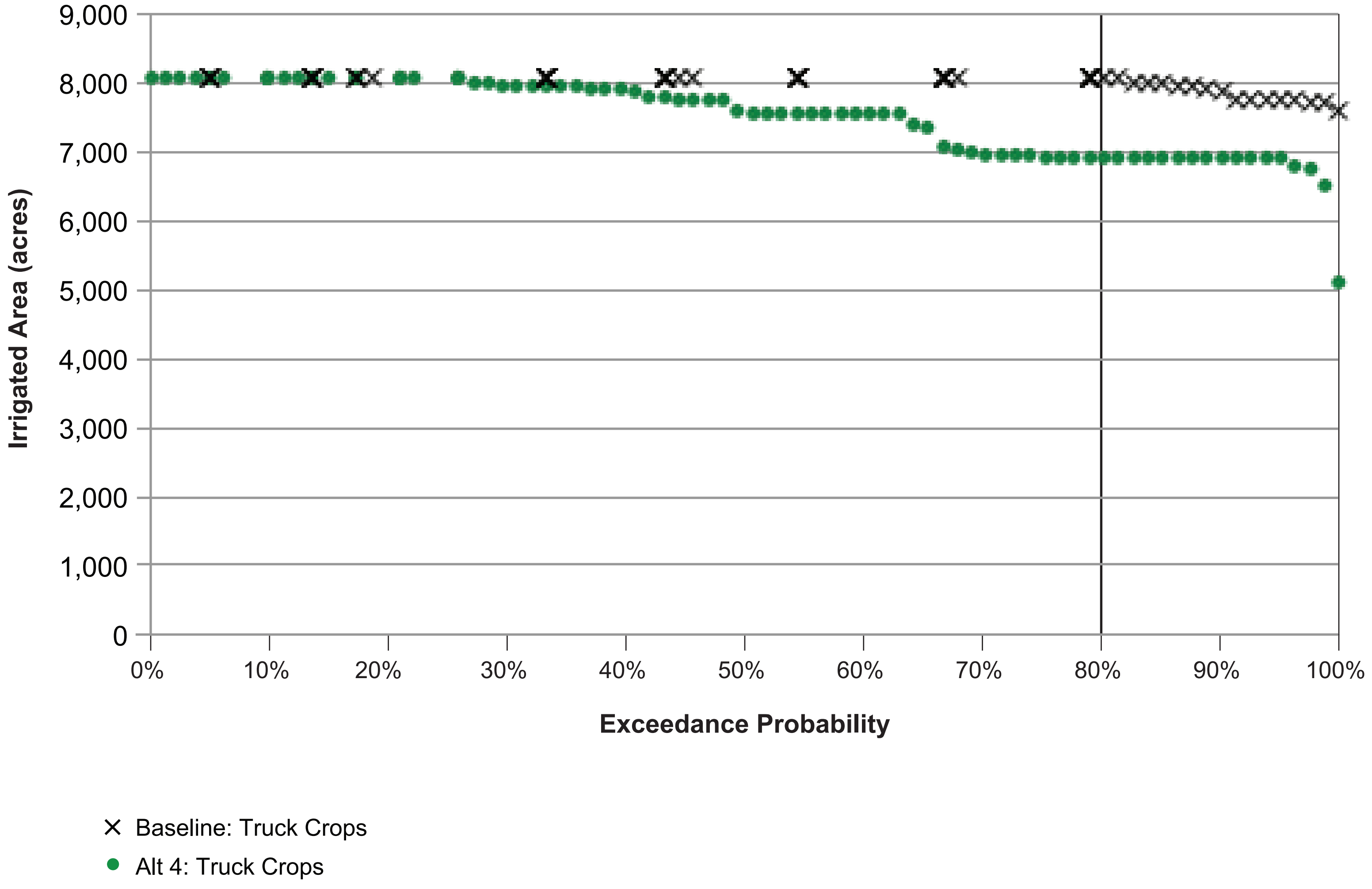
Figure 11-22e

Irrigated Acreage in TID for Pasture under Alternative 4



Graphics...00427.11 (1-11-2016)

Figure 11-22f
Irrigated Acreage in TID for Truck Crops under Alternative 4

Table 11-20. Percent Average Acreage Reduction from Baseline for Irrigation Districts Impacted under LSJR Alternative 4 for 2009 and 2014 Groundwater Pumping Levels

	Groundwater Pumping Level	
	2009	2014
District	% Crop Reduction	
SSJID	11	8
OID	20	14
MID	28	5
TID	25	11

SSJID = South San Joaquin Irrigation District

OID = Oakdale Irrigation District

MID = Modesto Irrigation District

TID = Turlock Irrigation District

Similar to the availability of feasible mitigation above under LSJR Alternative 2 (20 percent unimpaired flow), while it is possible that some of the water-diversion and use measures, including irrigation efficiency, may have some applicability to reducing impacts or could be implemented as part of the individualized water right proceedings that are expected to take place to implement the flow objectives, any application of these measures at this point by the State Water Board is infeasible, as explained in LSJR Alternative 2. Furthermore, it is unknown whether these activities would reduce the significant impacts to less-than-significant levels. Irrigation efficiency measures could be implemented by local water purveyors, irrigation districts, or groundwater management districts to reduce the amount of water applied to crops while still meeting crop water demands. Irrigation efficiency would serve to keep as much agricultural acreage in production as possible. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies can and should adopt irrigation efficiencies described in LSJR Alternative 2 and local land use authorities can and should impose development conditions and require conservation easements where allowed to mitigate for the loss of agricultural lands; however, given the uncertainty of the extent to which these mitigation measures would occur and because they may not fully mitigate impacts, impacts would remain significant. While adaptive implementation method 1, could reduce the percent of unimpaired flow to 50 percent and potentially reduce impacts on agricultural resources (discussed below), it cannot be independently applied as an alternative because it is part of LSJR Alternative 4 and because the purpose of adaptive implementation is to benefit fish. Therefore, according to the number of acres that would no longer be considered Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as predicted by the SWAP model, and the possibility of conversion of these acres to nonagricultural land uses, impacts on agricultural resources would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on agriculture. For reasons discussed under LSJR Alternative 3, adaptive implementation method 3 would not affect agricultural impacts associated with LSJR Alternative 4. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the February-June, 60-percent unimpaired flow requirement (to 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3 (i.e., less severe for agricultural resources, but still significant).

Irrigation efficiency measures and adaptive implementation method 1 could potentially reduce impacts, but likely not to a less-than-significant level. Applying adaptive implementation method 1 independent of LSJR Alternative 4 is infeasible given adaptive implementation is for the benefit of fish. Therefore, the significant impacts on agricultural resources are based on the number of acres of crop loss predicted by the model and the unknown ability of pumping groundwater or irrigation efficiencies to offset the loss of crop acreage. Impacts would remain significant and unavoidable.

SDWQ Alternatives

While the SDWQ alternatives are expected to maintain historical salinity concentrations in the southern Delta, the potential crop yield under the SDWQ alternatives is estimated by assuming year-round irrigation salinity concentrations of 1.0 dS/m and 1.4 dS/m for SDWQ Alternatives 2 and 3, respectively. The crop yield estimated under each of the alternatives is then compared with baseline results to determine the associated crop yield impacts of the alternatives. This information is used to qualitatively discuss if conversion to nonagricultural uses would take place.

SDWQ Alternative 2: (Less than significant)

Using the modeling approach described in Section 11.4.2, *Methods and Approach*, with a 20 percent leaching fraction, under either a median or minimum amount of precipitation, there was no yield reduction for dry beans irrigated with water containing a salinity level (ECw) of 1.0 dS/m. In addition, Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta,* reports that studies in the LSJR area of potential effects have shown that the highest soil salinities (ECe) and lowest apparent leaching fractions occurred at locations where water quality was the best and that higher leaching fractions and lower salt accumulations (ECe) were found at the locations where more saline irrigation water was used (1.1 dS/m or more). For this reason, it is reasonable to assume that salt-sensitive crops would not be affected. Since dry bean is the southern Delta crop most sensitive to salinity (Table 11-12), and given that the yield for dry beans is not affected, then the yield of crops with higher salt tolerance would not be affected. Crop production would not be substantially reduced, and Prime Farmland, Unique Farmland or Farmland of Statewide Importance would not be converted to nonagricultural uses. Impacts on agricultural resources would be less than significant.

SDWQ Alternative 3: (Less than significant)

Using the modeling approach described in Section 11.4.2, *Methods and Approach*, there is a 5 percent yield reduction for dry bean irrigated with 1.4 dS/m water, with a minimum amount of precipitation and a leaching fraction of 20 percent. When the median level of precipitation is used, the yield decline is less than 1 percent. For almonds, the yield decline is 3 percent with a leaching fraction of 15 percent and minimal precipitation; with the median level of precipitation the yield decline is less than 1 percent. For alfalfa there was no yield decline under the 15 percent leaching fraction with minimal precipitation. In addition, Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–*

San Joaquin Delta, reports that southern Delta studies have shown that the highest soil salinities (ECe) and lowest apparent leaching fractions occurred at locations where water quality was the best and that higher leaching fractions and lower salt accumulations (ECe) were found at the locations where more saline irrigation water was used (1.1 dS/m or more). Because dry bean is the southern Delta crop most sensitive to salinity (Table 11-12) and given that the reduction in yield for dry beans is less than 10 percent, there is little potential for any yield impacts on crops with higher salt tolerance. Accordingly, a 10 percent yield decline is not expected, and it is reasonable to assume that Prime Farmland, Unique Farmland, or Farmland of Statewide Importance would not be converted to nonagricultural uses. Impacts would be less than significant.

Impact AG-2: Involve other changes in the existing environment which, due to their location or nature, could result in a conversion of farmland to nonagricultural use

Other changes to the existing environment that could result from the LSJR and SDWQ alternatives include changes to the timing and magnitude of flows in the tributaries, the loss of farmland upon which other agricultural production relies, and the amount of farmland in production that could be reduced as a result of these changes.

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Agricultural lands along the Stanislaus River include orchard, field, and vegetable crops. An investigation by the U.S. Attorney in Sacramento, California (USDOI 1982) found that when the river is over 1,250 cfs at Ripon, the high water table (i.e., seepage) can affect fields, specifically a 60-acre sugar beet field on the Collier Ranch, and that at flows above 1,500 cfs, the water tables rises sufficiently to damage almond and walnut orchards adjacent to the river. To monitor the water table, auger holes were dug on six properties that were thought to be susceptible under high river flow conditions.

Flows greater than 1,500 cfs currently exist on the Stanislaus River. Such flows typically occur more than 30 percent of the time in March, April, and May and less than 20 percent of the time the remainder of the year (Tables 6-13 and 6-14 in Chapter 6, *Flooding, Sediment, and Erosion)*. Flows greater than 1,500 cfs on the Stanislaus River are not considered to increase in frequency under LSJR Alternative 2 when compared to baseline (Table 6-14 in Chapter 6, *Flooding, Sediment, and Erosion*).

For this analysis, it is assumed that regardless of what crop is grown on the land, a high water table could still impact agricultural production. However, if this land is in sugar beet production, it would represent less than 3 percent of the total sugar beet production in the LSJR area of potential effects and approximately 0.1 percent of the total agricultural production in the LSJR area of potential effects (Table 11-5). Therefore, this would be a localized effect that would have a less-than-significant impact on the overall production of sugar beets in the area and would not substantially reduce crop production.

Six properties of walnut and almond orchards adjacent to the Stanislaus River were also reported as being susceptible to damage at flows above 1,500 cfs (USDOI 1982). As of 2010, there were approximately 2,605 acres of almonds and 1,288 acres of walnuts within the Stanislaus River 100-year floodplain (based on GIS analysis using 2010 CropScape Data published by the USDA (2016), and floodplain area data published by the Federal Emergency Management Agency (2016). The 100-year floodplain is inundated at volumes much greater than 1,500 cfs. For this area, in 2010 the gross annual revenue of orchards ranged from $1,500 to $2,000 per a (from the SWAP model, as described in Medellín-Azuara 2015). If 100 percent of this acreage was affected by seepage the revenue lost could range from $5.8 million to $7.8 million in value. This acreage represents only about 3 percent of baseline Almond and Pistachio (the crop category that most resembles walnuts and almonds) acreage and less than 1 percent of all agricultural production in the LSJR area of potential effects (Table 11-5). There would be no change in the frequency of flows at 1,500 cfs relative to baseline conditions and LSJR Alternative 2 would not increase the likelihood of a 100-year flood (Chapter 6, *Flooding, Sediment, and Erosion*). As such, it is reasonable to assume that a substantial reduction in agricultural production would not occur in the LSJR area of potential effects as a result of seepage when compared to baseline. Because there is no substantial reduction in crop production, acreage impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Flows greater than 1,500 cfs on the Stanislaus River would slightly increase in frequency under LSJR Alternative 3 when compared to baseline. The overall frequency of monthly flows greater than 1,500 cfs would increase from 14 percent to 16 percent at Ripon (Table 6-14 in Chapter 6). However, as described under LSJR Alternative 2, LSJR Alternative 3 would not increase the likelihood of a 100-year flood and effects would occur to less than 1 percent of the total agricultural production in the LSJR area of potential effects. Therefore, it is reasonable to assume that a substantial reduction in agricultural production, and thus acreage, would not occur in the LSJR area of potential effects as a result of seepage when compared to baseline. Impacts would be less than significant.

For economic viability, dairies rely, in part, on the proximity of cropland for feed and waste disposal. If cropland is in close proximity to a dairy or used by a dairy it may be considered a higher net revenue crop when compared to other cropland in the LSJR area of potential effects. Reduction in acreage for feed, particularly Alfalfa, can be offset through purchases of feed from production areas outside of the LSJR area of potential effects. Due to additional transportation costs, feed costs could go up; however, the increase in the cost of feed is not known because it depends on where dairies source feed from and the competition for the feed from other users. As an example of the uncertainty in feed costs, statewide feed costs decreased in 2015 ($10.41/hundredweight [112 pounds]) from 2014 ($11.05/hundredweight) prices (Sumner 2016).

During water-short years, dairy and cattle operations relying on Alfalfa (SSJID, MID, and TID), Grain (MID), and Pasture (SSJID, OID, MID, and TID) production could experience some input cost increases if reductions to these crop types occur. Although SWAP results predict a reduction of lower net revenue crops, such as Alfalfa, under LSJR Alternatives 3, SWAP could be over predicting fallowing from feed crops in particular Alfalfa and Pasture. Considering that Alfalfa and Pasture crops could be associated with dairies (i.e., have higher net revenue), potentially less acreage could actually go out of production. In addition, Alfalfa and Pasture are able to survive without receiving their full water requirements during an irrigation season; however, there could be a decline in yield for these crops or a reduction in the full use of Pasture if the full water requirements were continually restricted (Putnam et al. 2015a, 2015b). Silage corn can only be grown locally for cost effectiveness. Limited substitution of silage corn in dairy cows is considered in SWAP because of the minimum silage constraints in the model and hence less fallow land in silage crops is predicted because of the minimum silage constraints in the model. This is exemplified in the recent drought, as dairy operators obtained water supplies from willing sellers within an irrigation district in order to manage waste disposal and meet minimum dietary requirements of silage corn particularly.

A review of agricultural commodity data shows that dairies either exceed or are competitive with other agricultural commodities in the LSJR area of potential effects (Table 11-21). As such, some commodities, such as field and grain and even higher net value crops in the spectrum, may decrease in production if dairies obtain needed water supplies during drier conditions. Given the gross revenues of different agricultural commodities, it is likely that dairies would be competitive for water supplies (Table 11-21), as they have in the past. For example, irrigation water cost for dairy feed in the San Joaquin Valley represent about 9 percent of the cost of farm milk production in 2015, and is not considered the dominant cost when evaluating all other costs associated with dairies (Sumner 2016).

Table 11-21. Gross Revenue of Agricultural Commodities

Agricultural Commodity	Gross Value ($)
Dairy	2,211,377,149
Hay Alfalfa	50,337,017
Oranges	8,074,381
Almonds	883,756,849
Vegetables (Truck in SWAP)	121,637,329

Source: USDA 2015.

The three sectors of beef cattle operations may adjust differently under LSJR Alternative 3 conditions. Beef cattle feedlot operations rely on grains and oilseeds from out of the state are imported (Medellin-Azuara et al. 2016). As such, the beef cattle feedlot segment is more vulnerable to fluctuations in output commodity prices (e.g., feed and where it is coming from) than water supply conditions and would be unlikely to be affected by reduced surface water conditions (Medellin-Azuara et al. 2016). The cow-calf and feeder cattle segments of the beef cattle industry may be more vulnerable. These two segments rely on pasture and other forages prior to weaning calves and before transitioning to feedlots. Under reduced surface water conditions, summer Pasture (typically irrigated) can become scarce and may limit grazing opportunities. If this is combined with poor winter grass conditions, the size of these operations could be reduced (Medellin-Azuara et al. 2016). Pasture is typically grown on land with soils, slopes or other characteristics support pasture rather than other crops (Cattlemen's Beef Board and Cattlemen's National Beef Association 2009). As such, it is likely these areas would be maintained as Pasture. In addition, these lands can provide Pasture for 4 or 5 months per year during the wet season and so the timing could offset potential effects. Further, cow-calf operations are able to substitute fodder and other food sources for irrigated pasture land, if needed (The Pennsylvania State University

2013). Finally, as discussed above, SWAP is potentially over predicting effects on Pasture and as such, not all of the lands would be reduced under LSJR Alternative 3.

Given cost of feed input compared to other dairy and beef cattle inputs and the availability of the feed input for both dairy and beef cattle, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies and beef cattle operations would be converted to nonagricultural uses. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Flows greater than 1,500 cfs on the Stanislaus River would increase in frequency under LSJR Alternative 4 when compared to baseline. The overall frequency of monthly flows greater than 1,500 cfs would increase from 14 percent to 22 percent at Ripon (Table 6-14 in Chapter 6). However, as described under LSJR Alternative 2, LSJR Alternative 4 would not increase the likelihood of a 100-year flood and effects would occur to less than 1 percent of the total agricultural production in the LSJR area of potential effects. Therefore, it is reasonable to assume that a substantial reduction in agricultural production, and thus acreage, would not occur in the LSJR area of potential effects as a result of seepage when compared to baseline. Impacts would be less than significant.

Similar to the discussion above under LSJR Alternative 3, dairy and cattle operations that rely on Alfalfa, Corn, Grain, and Pasture production from SSJID, OID, MID, and TID could experience some input cost increases during water-short years. Dry forms of feed crops such as alfalfa can be imported to replace the reduction in locally grown feed crops that may occur when the regional markets for these crops exist. A review of data shows that dairy value either exceeds or is competitive with other crops in the LSJR area of potential effects (Table 11-21). As such, some crops, such as Field and Grain and even higher net value crops in the spectrum, may decrease in production if dairies obtain water supplies. Given the gross revenues of different agricultural commodities, it is likely that dairies would be competitive for water supplies (Table 11-21). Furthermore, because of the equitable distribution policies of local water suppliers described in Section 11.3, *Regulatory Background*, it is anticipated dairy operators could receive water within irrigation districts that apply reductions equally across agricultural uses. Given cost of feed input compared to other dairy and beef cattle inputs and the availability of the feed input for both dairy and beef cattle, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies and beef cattle operations would be converted to nonagricultural uses. Impacts would be less than significant. Impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3: (Less than significant)

As discussed under Impact AG-1 for SDWQ Alternatives 2 and 3, reductions in crop acreage in the SDWQ area of potential effects are not expected beyond what may typically occur in the area as a result of normal farming practices. Therefore, it is reasonable to assume that a conversion of farmland to nonagricultural uses would not occur in the SDWQ area of potential effects. Impacts would be less than significant.

Impact AG- 3: Conflict with existing zoning for agricultural use or a Williamson Act contract

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternatives 2, 3, and 4 (Less than significant/Less than significant with adaptive implementation)

Lands under Williamson Act contracts are enforceably restricted to compatible open space or agricultural uses, generally for rolling 10-year or 20-year terms, and the LSJR alternatives do not alter those restrictions. Therefore, any reduction in surface water supplies expected under LSJR Alternatives 2, 3, and 4 would not conflict with Williamson Act provisions because the existing agricultural lands can and must be maintained in compatible open space and agricultural uses, which can include non-irrigated agricultural uses. Specifically, the Williamson Act holds that a reduction in the economic character of existing agricultural land is not a sufficient reason for cancellation of a contract. There is enough annual crop acreage for rotation if the plantings of annual crops such as Corn and Grain were rotated in years with reduced irrigation supply such that all the lands would be irrigated at least once every other year or fallowed in other years. There is enough annual crop acreage for rotation if the plantings of Grain were rotated in years with reduced irrigation supply such that all lands would be irrigated at least once every other year or dryland farmed or fallowed in other years. These practices are all considered agricultural uses. There is potential for Alfalfa and Pasture to survive without receiving their full water requirements during an irrigation season (i.e., deficit irrigation), even though they are permanent-type crops (Putnam et al. 2015a, 2015b). Deficit irrigation would keep this acreage in agricultural use. While cities or counties may designate boundaries for agricultural preserves, create farmland security zones, enter into conservation easements, or enter into Williamson Act contracts, they do not have the authority to require landowners to sparticipate in such measures in the first instance. However, once a land owner has entered into a Williamson Act contract he or she must abide by the contract provisions until he or she chooses to non-renew, cancel, or otherwise withdraw. Cities and counties administering agricultural preserves may enforce existing Williamson Act contracts, but it is speculative and unknown to what extent, if any, contracts covering such lands would be subject to nonrenewal, cancellation, or enforcement. Importantly, there are serious financial disincentives to landowners for each of those outcomes: nonrenewal carries with it significant tax disadvantages; cancellation is at the option of the city or county administering the preserve and can include cancellation fees; and, enforcement can result in financial penalties. Therefore, LSJR Alternatives 2, 3, and 4 would not conflict with the existing Williamson Act, and impacts would be less than significant.

LSJR Alternatives 2, 3, and 4 would not conflict with existing zoning for agricultural use. Only cities and counties enact zone change. The LSJR alternatives would not change zoning and would not require a discretionary action that conflicts with a land zoned for agriculture. LSJR Alternatives 3 and 4 could result in reduced irrigation available to designated prime, unique, and farmland of statewide importance as described above under Impact AG-1; however, if the lands do not receive irrigation, they could be dryland farmed, rotated, deficit irrigated, or fallowed, all of which would be consistent with agricultural zoning. Therefore, a conflict would not occur as a result of LSJR Alternatives 2, 3, and 4, and agricultural land would continue to maintain existing zoning. Impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3: (Less than significant)

Williamson Act contracts for lands in the SDWQ area of potential effects total 83,614. While Williamson Act lands do not need to be irrigated to be maintained within Williamson Act contracts, agricultural uses in the southern Delta currently divert surface water from existing waterways, expecting it to be of suitable water quality to irrigate existing crops. SDWQ Alternatives 2 and 3 would not conflict with existing Williamson Act contracts or zoning for agricultural use because they would not result in an action that would change existing zoning or activities consistent with agricultural zoning, and Williamson Act contracts would continue in the southern Delta. Therefore, impacts would be less than significant.

Impact AG- 4: Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, for the No Project impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2, 3, and 4 (Less than significant/Less than significant with adaptive implementation)

Implementation of the LSJR alternatives do not involve general plan amendments to convert currently designated agricultural land to other uses. LSJR Alternatives 2, 3, or 4 would result in a change in the volume of water within existing reservoirs or rivers. This change would not conflict with applicable land use plans, policies, or regulations in the LSJR area of potential effects. LSJR Alternatives 3 or 4 could result in physical environmental effects associated with reducing surface water diversions that primarily serve agricultural lands, as described under Impact AG-1. Some agricultural land could be taken out of use as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, given reductions in the availability of irrigation water due to reductions in surface water diversions under LSJR Alternatives 3 and 4. However, some of these lands could remain in agricultural use even if they are not irrigated, as described under Impact AG-3. Thus, the reduction in surface water diversions due to implementation of LSJR Alternatives 3 or 4 would not conflict with existing land use plans or policies that protect or preserve agricultural lands. Although LSJR Alternatives 3 and 4 could result in constraints on agricultural use and may limit it in some cases, LSJR Alternatives 2, 3, and 4 would not conflict with any land use plan or policy. Therefore, impacts would be less than significant.

SDWQ Alternatives

SDWQ Alternatives 2 and 3: (No impact)

The SDWQ alternatives do not include general plan amendments or zone changes and would not result in changes to existing land designations or zoning. Furthermore, the agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops. Therefore, there would be no impact.

11.6 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows, as described in Chapter 5, *Surface Hydrology and Water Quality*, would not cause potentially significant impacts on agricultural resources in the extended plan area. There are limited agricultural resources in the extended plan area and no designated Prime, Unique, or Farmland of Statewide Importance (California Farmland Mapping and Monitoring Program webpage). Much of the extended plan area is designated as nonagricultural with some acreage in grazing in Mariposa County near Lake McClure (California Farmland Mapping and Monitoring Program n.d.) and individual small water rights used for irrigated pastures, orchards, and occasional vineyards. However, these are a small volume with limited or no storage volume that could be affected by bypass flow requirements (State Water Board 2016). Any reduction in surface water supplies that are available for irrigation in the extended plan area would be similar to that described for the plan area, but smaller in magnitude. Therefore, impacts would be less than significant.

11.7 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 12
Cultural Resources

12.1 Introduction

This chapter describes the environmental setting of cultural resources, including paleontological resources (described in Section 12.2, *Environmental Setting*) and the regulatory background associated with these resources. This chapter evaluates environmental impacts on cultural resources that could result from the Lower San Joaquin River (LSJR) alternatives and, if applicable, it also offers mitigation measures that would reduce significant impacts.

The potential of cultural resources to exist within the plan area is used to determine if flow and reservoir conditions under the LSJR alternatives, when compared to baseline, would impact cultural resources, including paleontological resources. The area of potential effects evaluated in this chapter is primarily the area of fluctuation around the three reservoirs and the channels of the three eastside tributaries[1] and the LSJR within the plan area as, described in Chapter 1, *Introduction*. A broad cultural context for potential impacts in the plan area is provided in this chapter and in Appendix I, *Cultural Resources Overview*.

The extended plan area, also described in Chapter 1, *Introduction*, generally includes the area upstream of the rim dams.[2] The area of potential effects for the extended plan area is similar to that of the plan area and includes the zone of fluctuation around the numerous reservoirs that store water on the Stanislaus and Tuolumne Rivers. (Merced does not have substantial upstream reservoirs that would be affected.) It also includes the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Resources Control Board (State Water Board) determined whether the plan amendments[3] would cause any adverse impact on resources in each of the listed environmental categories and provided a brief explanation for its determination. Impacts in the checklist that are identified as "Potentially Significant Impacts" are discussed in the resource chapters. Appendix B identified the LSJR alternatives as having a potentially significant impact on cultural resources because the project could potentially degrade or destroy existing cultural resources within the plan area. Accordingly, this chapter evaluates the potential of the LSJR alternatives to impact cultural resources by determining whether the alternatives would: (1) cause a substantial adverse change in the significance of a historical or archaeological resource, (2) disturb any human remains, including those interred outside formal cemeteries, or (3) directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

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[1] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[2] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

[3] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

Potential cultural resource impacts were generally evaluated using changes in river flows and changes in reservoir water surface elevations that are expected to result from the implementation of each of the LSJR alternatives. For this evaluation, the potential for known and unknown significant cultural resources to exist at the three reservoirs and along the rivers was determined. Following this determination, a qualitative analysis of the effects of altering reservoir elevations or modifying flows using the results of the State Water Board's Water Supply Effects (WSE) model was performed. Results indicated that LSJR alternatives 2–4 would change the rates of flow of the three eastside tributaries and the LSJR within the plan area, the maximum and minimum surface elevations of the three reservoirs, and the timing that these fluctuations in surface water elevations occur. For the three large reservoirs, the WSE model results were summarized in two ways to characterize the effect of the LSJR alternatives on both high and low reservoir elevations in order to assess changes in reservoir elevation that may: (1) increase inundation of cultural resources that are typically out of the water, or (2) increase exposure of cultural resources that are typically below the water surface. These two assessments also capture the change in the range of reservoir elevations. For the three eastside tributaries and the LSJR, the modeled changes in flow are the primary mechanism for impacts on cultural resources. The comparison of monthly cumulative distributions of flows, in conjunction with the individual monthly average changes in flow, provides an appropriate measure of hydrologic changes resulting from the LSJR alternatives.

A summary of the potential impacts of the LSJR alternatives on cultural resources is provided in Table 12-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3 and 4 each include four methods of adaptive implementation. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 12-1 includes impact determinations with and without adaptive implementation.

Any change in salinity in the southern Delta as a result of southern Delta water quality (SDWQ) Alternatives 2 or 3 is expected to be similar to that of the historic range of salinity because Vernalis water quality would be maintained under the SDWQ alternatives through the program of implementation. Since the chemical properties of the baseline water quality conditions would not change, there would be no potential to substantially adversely impact significant cultural resources. Therefore, the SDWQ alternatives are not discussed in this chapter. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on cultural resources. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

Impacts related to the No Project Alternative (LSJR/SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* Chapter 16, *Evaluation of Other Indirect and Additional Actions,* includes discussion of impacts related to actions and methods of compliance.

Table 12-1. Summary of Cultural Resource Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact CUL-1 Cause a substantial adverse change in the significance of a historical or archaeological resource			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternatives 2, 3, and 4	The expected changes in reservoir elevations are within historical fluctuations, and known or unknown significant cultural resources are expected to continue to be inundated or exposed as usual under current operations. Additionally, historic property management plans at the reservoirs would continue to be implemented Changes in river flows are not expected to alter the low potential for significant cultural resources to remain along rivers due to previous natural and anthropogenic disturbances.	Less than significant	Less than significant
Impact CUL-2 Disturb any human remains, including those interred outside formal cemeteries			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	The expected changes in reservoir elevations are within historical fluctuations and are not expected to affect human remains due to low potential for human remains to exist within the fluctuation zone of the reservoirs. Additionally, historic property management plans at the reservoirs would continue to be implemented Additionally, any human remains would be treated in accordance with existing state and federal regulations. Changes in river flows are not expected to alter the low potential for undocumented human remains to exist along rivers due to previous natural and anthropogenic disturbances.	Less than significant	Less than significant
Impact CUL-3 Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternatives 2, 3, and 4	The expected changes in reservoir elevations are within historical fluctuations, and unique paleontological or geologic resources, specifically caves, would continue to be inundated and exposed as usual under current	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	operations. Additionally, the documented caves are managed and protected under a cave management plan. Changes in river flows are not expected to alter the low potential for paleontological resources to exist along rivers due to depth of occurrence of rock units with high paleontological potential.		

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 12.4.2, *Methods and Approach*, of this chapter.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in the continued implementation of flow objectives and salinity objectives established in the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan). See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

12.2 Environmental Setting

The environmental setting for cultural resources in the plan area is described below according to cultural resources that are historic or archaeological (including sites with human remains), and paleontological in origin. The geographic scope of the plan area potentially affected by cultural resources impacts is defined by the cultural setting and ethnographic territory of the prehistoric, ethnohistoric, and historic peoples who have occupied the northern San Joaquin Valley and adjacent Sierra Nevada foothills region of inland California, as well as by accessible, near-surface areas in this region exhibiting a high paleontological potential (e.g., Calaveras Formation caves). The LSJR alternatives would apply to the LSJR up to its confluence with the Merced River and to the lower portions of the three eastside tributaries to the LSJR (Stanislaus, Tuolumne, and Merced Rivers) upstream to, and including, the reservoirs (New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure), impounded by the three rim dams (New Melones, New Don Pedro, and New Exchequer Dams).

Cultural resources include archaeological sites of prehistoric or historic origin, built or architectural resources older than 50 years (e.g., historical resources), traditional or ethnographic resources, and paleontological resources (e.g., fossil deposits of paleontological importance). A prehistoric or historic archaeological site, district, built environment resource, or traditional cultural resource that is recognized as historically or culturally significant may be determined to be a *historical resource* as defined by state law. (California Public Resources Code [Pub. Resources Code], § 21084.1; California Code of Regulations [Cal. Code Regs.], tit. 14, § 15064.5, subd. (a).)

Archaeological resources include both prehistoric and historic remains of human activity. Built environment resources include an array of historic resources such as buildings, structures, and objects serving as a physical connection to California’s past. Traditional or ethnographic cultural resources may include Native American sacred sites (traditional cultural properties), traditional cultural places, and traditional resources of any ethnic community that are important for maintaining the cultural traditions of any group.

Prehistoric site locations are often predicted using environmental variables, particularly the availability of water and food, because site occupation and exploitation of natural resources were primarily based on subsistence essentials. For historic-era sites, historical settlement in this region was influenced primarily by the growth of mining in the foothills, agriculture in the valley, and the development of a transportation network of rivers, roads, and railroads connecting the valley and foothills. Many archaeological sites in the region, particularly along the river drainages, have been destroyed by mining practices and developments in agriculture and irrigation, or previously have been affected by the construction of dams and reservoirs or other development. Although remnants of sites have been discovered within the region, many have been highly disturbed.

Paleontological resources, including mineralized, partially mineralized, or unmineralized bones and teeth, soft tissues, shells, wood, leaf impressions, footprints, burrows, and microscopic remains, are more than 5,000 years old and occur mainly in Pleistocene or older sedimentary rock units.

The following sections describe the environmental setting for cultural resources in the reservoirs, and rivers in the plan area: Section 12.2.1, *Reservoir Historic or Archaeological and Paleontological Resources,* describes the environmental setting for New Melones, New Don Pedro, and Lake McClure; and Section 12.2.2, *River Historic or Archaeological and Paleontological Resources*, describes the environmental setting for the three eastside tributaries and the LSJR. For additional information see Appendix I, *Cultural Resources Overview,* provides an overview of the prehistoric, historic, and paleontological setting of the northern portion of the San Joaquin Valley and the adjacent foothills.

12.2.1 Reservoir Historic or Archaeological and Paleontological Resources

New Melones Reservoir

Prehistoric and Historic Resources

The U.S. Army Corps of Engineers (USACE) began construction of the New Melones Dam and reservoir, spillway, and powerhouse on the Stanislaus River in 1966 and completed it in 1979. Management of the project was transferred to U.S. Bureau of Reclamation (USBR) in 1979, and the reservoir is now part of the Central Valley Project (CVP). Archaeological survey, excavation, and analysis were conducted for the project between 1968 and 1981, documenting nearly 700 prehistoric and historic-era sites (Moratto 1984:312). The New Melones Archaeological District, comprised of more than 500 archaeological sites, bedrock mortars, and historic-era homestead sites, is eligible for National Register of Historic Places (NRHP) inclusion (USBR 2010:5.90–5.91).
In addition to prehistoric habitation, rock art, and resource processing sites, mortuary chambers used between circa 1000 B.C. and A.D. 700 were identified in numerous caves in the plan area (Moratto 2002:40). The reservoir inundated the Gold Rush era mining towns of Bostwick Bar, Pine Log, and Robinson’s Ferry (later renamed Melones, and now State Historical Landmark #276) (USBR 2007:3.14). Completed in 1988, the 10-volume cultural report on the New Melones project presented the evidence for a local archaeological sequence, with occupation of the area beginning as early as 10,000 years ago (USBR 2010:5.84).

A study completed in 2008 for the *New Melones Lake Area Resource Management Plan and Environmental Impact Statement* (RMP/EIS) identified 643 prehistoric, ethnohistoric, and historic-era cultural resources within the New Melones Lake Area, which includes a total of

23,265 acres administered by USBR and the U.S. Bureau of Land Management (BLM) (USBR 2010:5.82). Prehistoric site types, some of which include lithic scatters, human remains, house depressions and/or shell scatters, bedrock mortar, midden, cave, and rock art. Historic site types are mining, homestead/ranching, water/power systems, transportation, cemetery, and historic feature.

Of the archaeological sites identified within the New Melones Lake Area, 122 sites are located in the permanent pool zone lower than 808 feet (ft) above mean sea level (MSL), 33 sites in the permanent pool/fluctuation pool zone 808–1,088 ft above MSL, 232 sites in the fluctuating pool zone, 24 sites in the fluctuating pool zone/above-pool area, 203 sites above the flood pool zone, and 5 sites that include portions in all zones (USBR 2007:3.1-3.3, Table R-9). The elevation of the remaining sites is uncertain. Of the archaeological resources located in the permanent pool zone, 66 sites are prehistoric and 75 sites are historic sites or features (USBR 2007:3.11–3.12, 3.14–3.15). Ninety-six prehistoric and 226 historic sites or features are located entirely or partially within the fluctuating pool zone; these have been subject to wave action, as well as erosion from cyclical inundation and exposure, and are considered by USBR to be most susceptible to damage from lakeside recreational use and vandalism. Known cultural resources above the flood zone include 69 prehistoric and 147 historic sites or features.

No historic-era built environment resources are referenced in the New Melones Lake Area Final RMP/EIS (USBR 2010:5.82–5.83).

Of the 6,735 total acres of the New Melones Lake Area that has not yet been surveyed for the presence or absence of cultural resources, 2,063 acres are below the maximum pool zone (USBR 2010:5.82–5.83, Table 5-14). The potential for a surface survey to yield newly identified cultural resources varies from low to very high depending on the management area and the density of previously recorded resources within each area. In management areas (USBR 2010: Figure 2-2) that have been completely inventoried (Bowie Flat, Dam and Spillway, Mark Twain) or in those under the maximum pool zone (Middle Bay, North Bay, and South Bay), the discovery of previously unidentified cultural resources is considered unlikely. The potential for surface discovery in nine management areas located under or partially under reservoir waters is considered low to moderate in one (Greenhorn Creek), moderate in two (Bear Creek, Carson), moderate to high in two (Camp Nine, French Flat), high in two (Coyote Creek, Westside), and very high in two (Parrotts Ferry, Stanislaus River Canyon). Four of the designated management areas are outside the reservoir boundary (Bowie Flat, Dam and Spillway, Peoria Wildlife Area, Tuttletown).

No TCPs or sacred lands have been identified as of February, 2010 within the New Melones Lake Area (USBR 2010:5.91). If identified after this date, TCPs are subject to the same impacts as archaeological sites.

All documented or currently undocumented historic properties[4] at New Melones Lake Area would be protected and managed by the *Resource Protection Plan* administered by the USBR at the New Melones Lake Area (USBR 2010:1.5, 5.81) (Section 12.3.1*, Federal [Regulatory Background]*).

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[4] *Historic property* is a term with defined statutory meaning at 36 CFR Section 800.16, subd. (l)(1), and refers to any cultural resource (i.e., prehistoric or historic district, site, building, structure, or object) included in, or eligible for inclusion in, the NRHP. The term includes properties of traditional religious or cultural importance to an Indian tribe that meet the NRHP criteria listed at 36 CFR Section 60.4.

Paleontological Resources

Geologic formations around the reservoir are pre-Tertiary metamorphic or igneous rocks with low paleontological potential; however, there are Calaveras Formation deposits in proximity to New Melones Reservoir (USBR 2010:5.5-5.8). Caves formed in the Calaveras Formation limestone deposits are unique geologic features, and the formation is also considered to have high paleontological potential because fossilized vertebrate remains have been recovered from its caves (UCMP 2012). Paleontological specimens have been discovered in the New Melones region inside the limestone caves. The caves are managed and protected in accordance with the directives of the *New Melones Lake Revised Cave Management Plan* administered by USBR (Section 12.3.1*, Federal [Regulatory Background]*).

Fossilized remains of Rancholabrean (younger Pleistocene and Holocene fauna) vertebrates recovered from more than a dozen Calaveras Formation caves include ground sloth, horse, deer, rabbit, squirrel, and mole, among others (UCMP 2012). In 1978, before the reservoir was filled, the BLM identified 87 caves within the New Melones Lake Area (USBR 2010:5.10–5.12). The specific location of caves ranked by the BLM as paleontologically significant is confidential, so the following discussion references all 87 caves. Of these, 30 of the 44 caves within the Stanislaus River Canyon are inundated or subject to inundation by the impounded waters. Of the 19 caves in the Coyote Creek Canyon, all but Lower Natural Bridges Cave are above the New Melones Dam spillway elevation of 1,088 ft above MSL. Coyote Creek flows through two caves, Upper and Lower Natural Bridges. In the Skunk Gulch and Grapevine Gulch areas, all 24 caves identified there are above spillway elevation. Five of the caves, including Upper and Lower Natural Bridges, are protected under the Federal Caves Protection Act of 1988. Of these, Lower Natural Bridges (Cave 85) and two others (Caves 25 and 54) are below the 1,088-foot MSL spillway level of New Melones Dam.

New Don Pedro Reservoir

The New Don Pedro Dam and reservoir on the Tuolumne River were completed in 1971. Archaeological investigations were conducted in the late 1960s but were fairly limited and not initiated before many of the archaeological sites already had been inundated or damaged (TID and MID 2011a:5.246). During 1970 and 1971, salvage archaeology in the reservoir basin recorded the remnants of 41 prehistoric sites (Moratto 1984:311). A July 2010 records search identified 61 prehistoric and historic archaeological sites within the boundary for the Federal Energy Regulatory Commission (FERC) New Don Pedro relicensing application (FERC Project No. 2299) (TID and MID 2011a: 5.255, 5.260–5.263). These include 32 prehistoric, 21 historic, and 2 multi-component sites; 6 sites with missing records are of unknown type. Prehistoric site types found at New Don Pedro Reservoir are bedrock mortar, kiln, lithic scatter, midden, and village; a few of these include human remains, shell scatters, house pits, or evidence for cave dwelling. Historic site types found at New Don Pedro Reservoir are foundations, rock walls, mining features, a gravestone, water conveyance systems, rock dam, roadbeds, debris scatters, and the former location of a mining town called Jacksonville. Of the 61 resources that are currently documented, four prehistoric sites have been determined eligible for inclusion in the NRHP and two prehistoric bedrock milling stations, as well as the former location of Jacksonville, which is now a State Historical Landmark (#419), are under the waters of New Don Pedro Reservoir (TID and MID 2011a:5.260–5.263, 2011b:4-5). An inventory and evaluation for NRHP eligibility of historic-era built environment resources is also in progress for the Don Pedro FERC relicensing application (TID and MID 2011b:8). A review of historic maps identified more than 50 locations where unrecorded historic-era sites or features may be present, such as roads, trails, buildings, mines, ditches, and the Hetch Hetchy railroad and aqueduct.

No TCPs or sacred lands have been identified as of November 2011 within the FERC relicensing boundary (TID and MID 2011c:3.5). A TCP study and consultation with local Native American groups or tribes is in the New Don Pedro FERC relicensing application. If identified, TCPs are subject to the same impacts as archaeological sites.

Geologic formations around the reservoir are pre-Tertiary metamorphic or igneous rocks (TID and MID 2011a:5.3) with low paleontological potential. No paleontological resources have been reported at New Don Pedro Reservoir (TID and MID 2011a).

All documented or undocumented cultural resources at New Don Pedro Reservoir would be protected and managed under a Historic Properties Management Plan (HPMP) (Section 12.3.3, *Regional or Local [Regulatory Background]*).

Lake McClure

Construction of the New Exchequer Dam and Lake McClure Reservoir on the Merced River was completed in 1967, prior to the 1972 enactment of the California Environmental Quality Act (CEQA). No cultural resources investigations were conducted in the plan area prior to 1977 (Merced Irrigation District [Merced ID] 2008: 7.12/4-5). Cultural resources surveys of approximately 6,200 acres were conducted for the Merced River Hydroelectric Project (FERC Project No. 2179) July 2008–July 2010 when lands usually inundated by Lake McClure were exposed and accessible due to lower than normal water levels (Merced ID 2012a: Exhibit E, 411-415). Merced ID has identified a total of 203 archaeological sites: 38 prehistoric, 149 historic-era, and 16 with prehistoric and historic-era components (Merced ID 2012b:27). Prehistoric site types that were identified include base and temporary camps, sparse lithic scatter, and milling station; site constituents at the camps include bedrock mortars, rock art, midden, and/or artifact scatters (Merced ID 2012b:28). Historic site types found include mining and mining related, road and trail, railroad element, farming and ranching habitation, industrial foundation, rock walls, water control element, refuse deposit, land survey marker, hydroelectric element, transmission line, and Bagby townsite (Merced ID 2012b:31). Multi-component sites include constituents of both prehistoric and historic period use (e.g., bedrock mortars and lithic scatters with cabin foundations, rock walls, or prospect pits) (Merced ID 2012b:30-31). No evidence of burials was observed at the location of a possible cemetery noted on a U.S. Geological Survey (USGS) quadrangle map, and no human remains were found during the survey (Merced ID 2012b:27, 48).

The 203 documented archaeological sites remain unevaluated for potential listing on the NRHP; all prior eligibility assessments are now considered premature (Merced ID 2012a: Exhibit E, 413–414).[5] Of the 203 sites, more than 45 prehistoric and historic-era sites are at or below the high water level (Merced ID 2011: Exhibit E, 334–335). Siltation was noted at 16 of the 45 sites and was considered a positive effect because it provides site protection. Among the Gold Rush-era mining communities now under the waters of Lake McClure are the town of Benton Mills (later renamed Bagby), the Exchequer mining camp, and the Horseshoe Bend camp (Merced ID 2008: 7.12/12).

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[5] It is anticipated that concurrence by the State Historic Preservation Officer (SHPO) on NRHP recommendations will be received by the end of 2012.

The archaeological site on the north and south banks of the Merced River comprising the townsite of Bagby/Benton Mills includes artifacts and 31 features (e.g., foundations, structure pads, pits, cisterns, retaining walls) (Merced ID 2012b:30–32). Although normally submerged, portions of the townsite were exposed during low water levels in 2009 (Merced ID 2010b:48). Remnants of Yosemite Valley Railroad elements were exposed during the low water levels in 2008 (Merced ID 2010b:34–38). During the survey within the two drought years (2008–2010), portions of a prehistoric base camp were also noted to extend underwater into the Merced River (Merced ID 2010b:28).

In 2011, Merced ID completed its study of the built environment for the Merced River Hydroelectric Project (FERC Project No. 2179) and determined the New Exchequer and McSwain Dams, powerhouses, and other project features, most of which were constructed in the late 1960s, are not currently eligible for inclusion on the NRHP but will be reevaluated once individual facilities become 50 years old (Merced ID 2012a: Exhibit E, 412–414). Seventeen buildings and structures more than 50 years old, including the original Exchequer Dam and a gauging station, were determined not eligible for NRHP listing. The original Exchequer Dam is normally submerged but was exposed in 2008 during the low water levels (below 720-ft elevation) (Merced ID 2010b:38).

No TCPs or sacred lands have been identified prior to submission of the final license application for the Merced River Hydroelectric Project in February 2012 (Merced ID 2012a: Exhibit E, 412). Ethnographic interviews with the Southern Sierra Miwok Nation (also known as the American Indian Council of Mariposa County, Inc.) may be conducted during the term of the new license and may identify potential TCPs. If identified, TCPs are subject to the same impacts as archaeological sites.

Geologic formations around the reservoir are pre-Tertiary metamorphic or igneous rocks (Merced ID 2012a, b: E3.47, Figure 3.3.1-1) with low paleontological potential. No paleontological resources have been reported within the boundaries of the Merced River Hydroelectric Project (FERC Project No. 2179) (Merced ID 2008, 2012b).

All documented or undocumented cultural resources at Lake McClure would be protected and managed under an HPMP (Section 12.3.3*, Regional or Local [Regulatory Background]*).

12.2.2 River Historic or Archaeological and Paleontological Resources

The potential presence or absence of cultural resources along the LSJR and the Merced, Tuolumne, and Stanislaus Rivers below the major rim dams and reservoirs has been presented in numerous documents. It was most recently summarized in the environmental impact statement/ environmental impact report (EIS/EIR) prepared to meet the flow objectives for the San Joaquin River Agreement (SJRA) (EA Engineering 1999). Due to the extensive reach of the LSJR and its three eastside tributaries, the summary of prehistoric and historic resources was presented in two tables tabulated by the total number of sites recorded in each county (EA Engineering 1999: Tables 3.7-2 and 3.7-3). Because little change is likely in the number of recorded cultural resources between the time that document was prepared and now, the same information is presented in Table 12-2 and Table 12-3 for the six counties traversed by the LSJR and the Stanislaus, Tuolumne, and Merced Rivers. Following Table 12-2 and Table 12-3 is a discussion of anthropogenic practices that have disturbed or destroyed archaeological sites during the historic period.

Geologic formations along the LSJR and the Stanislaus, Tuolumne, and Merced Rivers downstream of the rim dams include eight Pleistocene or older sedimentary rock units that have a high paleontological potential and are mapped at the surface or beneath Holocene-age alluvium. As detailed below, these units are the Ione, Laguna, Mehrten, Modesto, Moreno, Riverbank, Turlock Lake, and Valley Springs Formations, each of which has yielded the fossilized remains of plants, invertebrates, or vertebrates.

Prehistoric Resources

A summary of prehistoric resources by county is provided in Table 12-2. Together, these counties have more than 2,600 recorded prehistoric sites and range from 2 to 15 percent surveyed for cultural resources. Although people were present in the northern San Joaquin Valley and Sierra Nevada foothills as early as 12,000 years ago (Rondeau et al. 2007:65; Rosenthal et al. 2007:151), the majority of prehistoric sites documented in this region are less than 500 years old (EA Engineering 1999:3.106–3.109). Prehistoric sites recorded in the region include villages, seasonal occupation areas, burials, bedrock mortars, and lithic scatters, among other site types.

Table 12-2. Documented Prehistoric Sites by County

County	Total Number of Recorded Sites	Number of Prehistoric Sites	Percentage of County Land Surveyed	Areas with High Density of Sites	Overall Amount of Significant Disturbance in the County
Calaveras	1,527	929	10–15	Stanislaus, N. Fork Stanislaus, and Mokelumne Rivers; creeks, ridge flats	Low
Mariposa	1,264	856	5	Merced River; along creeks; in Yosemite National Park	Low
Merced	341	316	2	Unknown	Low
San Joaquin	249	189	5	San Joaquin and Mokelumne Rivers	Low to moderate
Stanislaus	350	280	3	Stanislaus, Tuolumne, and San Joaquin Rivers; along smaller creeks	Low
Tuolumne	3,540	Unknown	10	Stanislaus and Tuolumne Rivers; along creeks, ridge flats	Low
Totals	7,271	>2,570			

Source: EA Engineering 1999: Table 3.7-2.

Table 12-3. Documented Historic Resources by County in the Northern San Joaquin Valley

County	Number of Historic Sites[a]	Number of Properties in the NRHP	Number of California Historical Landmarks	Number of Evaluated Sites in California Historical Resources Inventory	Number of California Points of Historical Interest
Calaveras	598	13	42	56	4
Mariposa	408	29	8	15	0
Merced	25	12	5	13	7
San Joaquin	60	31	23	28	8
Stanislaus	70	17	5	12	7
Tuolumne	Unknown	19	20	79	4
Totals	>1,161	121	103	203	30

Source: EA Engineering 1999: Tables 3.7-2 and 3.7-3.
NRHP = National Register of Historic Places
[a] Calculated by subtracting the number of prehistoric sites from the recorded sites total provided in Table 12-2.

The areas in the six counties with the highest density of documented prehistoric sites are along the rivers (Table 12-2). The natural channels and meanders of these rivers have changed during the historic period by agriculture, irrigation, and mining practices, eliminating much of the natural floodplains and terraces, creating large in-channel and off-channel pits, and resulting in relatively static channels with narrow floodways confined by dikes or levees and agricultural fields. Other activities, such as hydraulic mining practiced in the New Melones Lake Area, have also disturbed much of the river areas (USBR 2010:5–9). Historical dredge tailings remain visible, flanking the Merced River between Lake McSwain and the community of Hopeton, and locally along parts of the Tuolumne River between the community of La Grange and the city of Waterford, indicating past areas of substantial disturbance (Merced ID 2010a:2.5–2.6; TID and MID 2011a:5.8). Large-scale aggregate mining along the Lower Merced and Tuolumne Rivers began in the early 1900s, and gold mining continued on the Lower Tuolumne River near Waterford into the mid-1900s, which also disturbed large areas of the rivers (Merced ID 2008:7.1/3–7.1/4; TID and MID 2011a:5.8).

The prehistoric site data reflect the preference of indigenous Californians for occupation along major watercourses, as well as the location of cultural resource management projects during the last three to four decades. Although a high number of prehistoric archaeological sites have been recorded along the rivers, sites have been destroyed by agriculture and irrigation practices, mining activities, or development. Furthermore, although Table 12-2 indicates the overall amount of significant disturbance in the six counties is relatively low, many of the known sites along the rivers have been highly disturbed by these types of activities (EA Engineering 1999:3.106).

Historic Resources

A summary by county of historic-era resources listed in the NRHP and the California Historical Resources Inventory is provided in Table 12-3. Together, these six counties have more than 1,000 recorded historic sites, of which more than 200 have been evaluated for listing in the NRHP, California Register of Historical Resources (CRHR), or local registers. The counties also include a number of historic properties listed in the NRHP, as well as California Historical Landmarks and Points of Historical Interest.

The historic period in the northern San Joaquin Valley is characterized by agricultural settlement, while mining activities influenced the east side of the valley and the Sierra Nevada foothills. The availability of water, as well as soil and landform type, was an important factor in early agricultural settlement and the interrelated locations of settlements and towns (Caltrans 2006:16–17, 34–35; Caltrans 2007:31–35).

Many of the documented historic-era resources in the six counties shown in Table 12-3 represent early settlement along the rivers during the Gold Rush era. Historic-era resources recorded along the rivers include buildings, structures or features of farming and ranching homesteads and rural communities, cemeteries, ferry landings, bridges, boat ramps and anchors, irrigation ditches or canals, early trails and roadways, rock walls, and assorted historic features and debris. In the Sierra Nevada foothills, resources related to the establishment and growth of mining, most of which are located along the rivers and smaller waterways, are represented by the buildings or remnants of camps and towns, refuse deposits, ditches, earthen dams, flumes, prospect pits, rock walls, and remains of stamp mills and other mining structures. Recorded resources also include transportation features, such as abandoned railroad grades, bridges, and roadways that connected the mines, ferry crossings, and settlements in the foothills to the San Joaquin Valley.

The natural channels and meanders of the LSJR and the Lower Stanislaus, Tuolumne, and Merced Rivers have been extremely modified by anthropogenic processes during the historic period, particularly by agriculture, irrigation, and mining practices, as discussed above. Although a high number of historic period archaeological sites or built resources have been recorded along the rivers, many have been highly disturbed or destroyed. Due to these disruptive practices and considering the young age of the alluvial landforms, the potential for buried historic-era archaeological sites along the four rivers is considered low (Rosenthal and Meyer 2004:106–107, Table 18).

In addition to agriculture, irrigation practices, and aggregate mining, commercial and residential development continues to affect riverside cultural resources. For example, the riverside town of Burneyville, dating from the 1870s, has been absorbed by the expanding City of Riverbank on the Stanislaus River (Hoover et al. 2002:521). The City of Modesto, initially established in 1870 as a railroad town, prospered in the early 1900s following the establishment of the Modesto Irrigation District (MID) and modern irrigation practices, and has now absorbed lands along both sides of the Tuolumne River, an area sensitive for the presence of historic-era sites related to ranching, agriculture, and early transportation practices (ICF Jones & Stokes 2008:V/8.3–5). Similarly, the City of Livingston’s proposal to expand its sphere of influence within the agricultural lands along the southern side of the Merced River could affect historic-era resources (PMC 2008:1.0/5–6, Figure 2-1).

Paleontological Resources

The Holocene riverine floodplain deposits along the LSJR and the lower portions of the three eastside tributaries are surrounded mainly by a mixture of continental rocks and deposits that include younger Holocene and older Pleistocene alluvium, three Pleistocene formations (Modesto, Riverbank, and Turlock Lake), and the Pliocene Laguna Formation (Page 1986: Plate 2). There is a large area with Holocene-age sand dunes mapped on the stretch of the Merced River between the communities of Irwin and Cressey. A few small sand dune patches are also mapped on the Stanislaus River west of the city of Riverbank. The sand dunes vary in thickness, reaching up to approximately 140 ft (Page 1986:19). At the confluence of the three eastside tributaries with the LSJR are Holocene flood basin deposits, some of which may be Pleistocene Modesto Formation (Page 1986:18–19). The thickness of the flood basin deposits in the San Joaquin Valley is estimated to be as much as 100 ft. The geologic formations (e.g., Miocene and Pliocene-age Mehrten Formation deposits) in the area have a high paleontological potential and have produced fossils as described in Table 12-4.

As discussed previously, the natural channels and meanders of the LSJR and the Merced, Tuolumne, and Stanislaus Rivers have been extremely modified by anthropogenic processes, particularly agriculture, irrigation, and mining practices. The natural floodplains and terraces have been mostly eliminated and the rivers confined by dikes, levees, and agricultural fields to relatively static channels with narrow floodways. During the historic era, native soils and sediments along the waterways draining westward from the foothills were displaced or buried by hydraulic mining and dredging, two particularly destructive mining methods that have been followed by modern large-scale aggregate mining (USBR 2010:5–9; Merced ID 2008:7.1/3–7.1/4; Merced ID 2010a:2.5–2.6; TID and MID 2011a:5.8). Although a number of fossil localities have been recorded along the rivers in the northern San Joaquin Valley, these are typically identified at depths below surficial Holocene-age deposits, including those native sediments rearranged by the anthropogenic practices that have recontoured and continue to recontour the riverine landscapes.

Table 12-4. Summary of Formations with High Paleontological Potential along the LSJR and Three Eastside Tributaries

Formation	Characteristics	Documented Fossil Presence
Ione	This middle Eocene rock unit extends more than 200 miles along the western edge of the Sierra Nevada (Creely and Force 2007:10). The marine sandstone and kaolinitic clay deposits have produced few marine body fossils, but trace burrows are abundant in many places.	Plant fossils have been recovered from deposits in Calaveras County near Comanche Reservoir, and invertebrate fossils in Mariposa, Stanislaus and Tuolumne Counties (UCMP 2012). Near the alternatives, the Ione Formation contains fossils of an Eocene fossil index bivalve at the Planicosta Buttes just south of the bridge at Merced Falls (Arkley 1962:5).
Laguna	This Pliocene rock unit consists of moderately consolidated, interbedded, arkosic alluvial gravel, sand, and silt (Helley and Harwood 1985:17). The gravel beds are predominantly comprised of quartz and metamorphic rock fragments.	Land vertebrate fossils have been found in fine-grained deposits of the Laguna Formation, mainly along the Sierra Nevada foothills.
Mehrten	This rock unit is composed of a sequence of dark sandstone, conglomerate, and claystone beds of late Miocene and Pliocene age (Arkley 1962:6-7) that unconformably overlie the Valley Springs Formation and consist of fluvial material reworked from volcanic deposits. In the Modesto area, the Mehrten attains a maximum thickness of about 1,200 feet where it lies at a depth of about 1,100 feet (Page 1986:11).	Microfossils and fossilized plant specimens have been identified in the Mehrten in Tuolumne County. Vertebrate fossils, including horse, pronghorn, and peccary, have been found at Goodwin Dam in Calaveras County, near Columbia and Two Mile Bar in Tuolumne County, and at Oakdale and Turlock Lake State Recreation Area in Stanislaus County (UCMP 2012).
Modesto	This Pleistocene rock unit was deposited by rivers still existing today and forms alluvial terraces and fans of major rivers along the axis of the Central Valley, including the San Joaquin and Sacramento Rivers, and is widely distributed along the rivers in the Sacramento and San Joaquin Valleys (Helley and Harwood 1985:10). The upper and lower members are dated 9,000–73,000 years ago.	The type section for this unit is along the south bluff of the Tuolumne River south of Modesto. Vertebrate fossils have been recovered from sediments in Merced, San Joaquin and Stanislaus Counties, and from nearly every major community in the San Joaquin Valley, including Fresno, Lathrop, Lodi, Manteca, Merced, Modesto, Stockton, and Tracy (UCMP 2012).
Moreno	Late Cretaceous in age, the Moreno Formation is the most important fossil locality of Cretaceous-aged marine vertebrates in the western United States.	Fossilized bony fish and plesiosaur and mosasaur remains have been found in Merced County near Laguna Seca and Rattlesnake Creeks (UCMP 2012). Moreno Formation deposits in Merced and Stanislaus Counties have produced invertebrate fossils. Microfossils have been found in Merced and San Joaquin Counties. Fossilized plant remains have been identified near Del Puerto and Little Salado Creeks in Stanislaus County.

Formation	Characteristics	Documented Fossil Presence
Riverbank	Formed during the Pleistocene age, 2.6 million to 11,700 years ago, this formation forms arkosic alluvial terraces and fans consisting of weathered, reddish gravel, sand and silt with some mafic igneous rock fragments. In the San Joaquin Valley, the Riverbank is broken into informal upper and middle members (Helley and Harwood 1985:11).	Fossils have mainly been recovered from fine-grained deposits, typically at a depth of 12 feet or more below the surface. Vertebrate fossils have been identified at various locations in Merced, San Joaquin, and Stanislaus Counties.
Turlock Lake	The alluvial sediments of this Pleistocene rock unit originated from the Sierra Nevada, and the formation is more widespread in the San Joaquin Valley than the Sacramento Valley (Helley and Harwood 1985:11-12). The age of the lower and upper members is estimated to at least 730,000 years and 600,000 years ago, respectively.	A series of exposures in Turlock Lake State Recreation Area in Stanislaus County are the type site for this formation. The most well-known locality is the Fairmead Landfill near Chowchilla in Madera County that has produced more than 3,000 fossil specimens from 35 different species (Dundas et al. 1996).
Valley Springs	This formation is generally considered to be late Miocene age (Arkley 1962:5; Page 1986:10). It consists of a fluvial sequence of rhyolitic ash, sandy clay, and siliceous gravel, and in most areas lies unconformably over the Ione Formation.	Fossilized plant specimens have been found near the community of Burson in Calaveras County (UCMP 2012).

12.2.3 Extended Plan Area

In general, the rocks along the rivers or reservoirs in the extended plan area are pre-Tertiary metamorphic or igneous rocks with a low potential for paleontological resources. Additionally, Calaveras Formation limestone does not occur in the vicinity of the extended plan area reservoirs on the Stanislaus and Tuolumne Rivers so no cave-associated paleontological resources are expected at those locations. Reservoirs in the extended plan area were created in the location of former lakes or along the rivers (Carpenter and Kirn 1988); both of these site types have extensive historical or archaeological use. Consequently, historical and archaeological sites may be associated with them (Carpenter and Kirn 1988; Anderson and Moratto 1996). Some of the historical sites are related to dam construction or to the dams themselves (Carpenter and Kirn 1988). Most of these sites are inundated by their associated reservoirs (Carpenter and Kirn 1988). Tuolumne and Mariposa counties are in the heart of California's historic "Mother Lode," and contain many historically significant Gold Rush era towns, and both historic and prehistoric heritage sites (USFS n.d.).

12.2.4 Southern Delta Historic or Archaeological, and Paleontological Resources

The setting and summary of cultural and paleontological resources for the southern Delta are not presented in this section because the water quality of the southern Delta is expected to remain within historical conditions under SDWQ Alternatives 2 or 3 (refer to Section 12.4.2, *Methods and Approach [SDWQ Alternatives]* for details).

12.3 Regulatory Background

12.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to cultural resources are described below.

National Historic Preservation Act of 1966

The National Historic Preservation Act of 1966 (NHPA) (54 United States Code [U.S.C.], § 300101 et seq.), as amended, is the primary federal law governing the preservation of cultural and historic resources in the United States. The NHPA establishes the federal government policy on historic preservation and the programs through which this policy is implemented. The NHPA requires federal agencies to take into account the effects of their undertakings on any historic property.

Archeological Resources Protection Act of 1979

The Archeological Resources Protection Act of 1979 (ARPA) (16 U.S.C., § 470aa) was enacted to protect archeological resources and site that are located on public lands and Indian lands. The ARPA governs the excavation and removal of archaeological resources and provides for enforcement to protect such sites.

American Indian Religious Freedom Act of 1978

The American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C., § 1996) established federal policy to protect and preserve rights involving traditional religions of Native Americans, including access to sacred sites.

Native American Graves Protection and Repatriation Act of 1990

For activities on federal lands, the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 U.S.C., § 3001 et seq.) provides for the repatriation of Native American cultural items and establishes procedures for the inadvertent discovery of Native American cultural items on federal or tribal lands.

Federal Cave Resources Protection Act of 1988

The Federal Cave Resources Protection Act of 1988 (16 U.S.C., § 4301et seq.) provides for the protection and preservation of significant caves on federal lands. It requires inventory of significant caves on federal lands, implementation of management measures, and provides certain protections of cave resources. It provides for the issuance of permits for collection or removal of cave resources and identifies criminal and civil penalties for prohibited acts.

12.3.2 State

Relevant state programs, policies, plans, or regulations related to cultural resources are described below.

California Environmental Quality Act of 1972

As discussed below in the impact analysis, CEQA (Pub. Resources Code, § 21000, et seq.) requires an evaluation of a project's impacts on historical and archeological resources in California. Public Resources Code section 21083.2 specifically addresses unique archeological. Archeological resources that are not unique do not need to be considered. (Pub. Resources Code, § 21083.2, subds. (a), (h).) State CEQA Guidelines (Cal. Code Regs., tit. 14, § 15064.5), "Determining the Significance of Impacts to Archaeological and Historical Resources," provides further direction regarding cultural resources. Subsection (a) defines the term "historical resources." Subsection (b) explains when a project may be deemed to have a significant effect on historical resources and defines terms used in describing those situations. Subsection (c) describes CEQA's applicability to archaeological sites and provides a method for analyzing archeological sites that are historical resources and those that are not.

California Public Resources Code

The California Public Resources Code contains various provisions protecting historic, archeological, and paleontological sites. For example, Section 5024.1 establishes the CRHR, which is to be used by state and local agencies to identify the state's historical resources and to indicate what properties are to be protect, to the extent prudent and feasible, from substantial adverse change. Other provisions of the Public Resources Code protect resources on public lands. (See, e.g., Pub. Resources Code, §§ 5097–5097.7 [providing for protection of resources on state and public lands].)

12.3.3 Regional or Local

Relevant regional or local programs, policies, or regulations related to cultural resource are described below.

New Melones Resource Management Plan

The purpose of the New Melones Resource Management Plan (RMP) is to develop a framework for management guidance on recreational, natural, and cultural resource management. The RMP document reflects contemporary resource needs for the New Melones Lake Area, while ensuring the Eastside Division of the CVP continues to meet its authorized purposes of flood control, water supply, power, recreation, water quality, and fish and wildlife enhancement. The RMP serves as the basis for future resource management decision-making that, when implemented, may result in the desired future condition for the management area.

All documented or currently undocumented historic properties at New Melones would be protected and managed by the Resource Protection Plan administered by USBR at New Melones Lake Area (USBR 2010:1.5, 5.81). Projects undertaken by USBR follow the directives and guidelines found in a series of Policy and Directives and Standards in the USBR manual that establish policies for cultural resource identification, evaluation, and management. The policies include standard unanticipated discovery and treatment measures should any previously unknown cultural resources, including human remains, be discovered during continued operation of the dam. In addition, USBR park rangers currently patrol recreational facilities and check on the condition of cultural resources in the New Melones Lake Area (USBR 2010:5.73).

New Melones Lake Revised Cave Management Plan

The caves at New Melones are managed and protected in accordance with the directives of the *New Melones Lake Revised Cave Management Plan* administered by USBR (USBR 2007:3.5; USBR 2010:1.16). The plan was prepared in 1996 and updated the information presented in the Draft Cave Management Plan of 1978. The current plan includes guidance to minimize publicity and access to sensitive cave locations, to avoid constructing trails, and to install gates where necessary for conservation purposes.

Historic Properties Management Plans

All documented or currently undocumented cultural resources at New Don Pedro Reservoir or Lake McClure/Lake McSwain are being protected and managed under HPMPs. These plans were completed or are being prepared following the Historic Properties Study Plan as part of the FERC hydropower water quality certification for the Don Pedro Dam (FERC Project No. 2299) and the Merced River Hydroelectric Project (FERC Project No. 2179) (TID and MID 2011b and Merced ID 2012a: Exhibit E, 413–415). Requirements to protect cultural resources at New Don Pedro Reservoir and Lake McClure/Lake McSwain include site management measures, training for all operations and maintenance staff, and routine monitoring of known cultural resources. HPMPs also include standard unanticipated discovery and treatment measures should any previously unknown cultural resources, including human remains, be discovered during continued operation of the dams.

12.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on cultural resources. It further describes the methods of analysis used to determine significance.

12.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the State Water Board's CEQA regulations. (Cal. Code Regs, tit. 23, §§ 3720–3781.) The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Cultural resource impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*, in this SED) and therefore, are evaluated in this analysis as to whether the alternatives could result in the following.

- Cause a substantial adverse change in the significance of a historical resource or archaeological resource as defined in the State CEQA Guidelines Section 15064.5. (Cal. Code Regs., tit. 14, § 15064.5.)
- Disturb any human remains, including those interred outside of formal cemeteries.
- Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

Where appropriate, specific quantitative or qualitative criteria are described in Section 12.4.2, *Methods and Approach,* for evaluating these thresholds. However, State CEQA Guidelines Section 15064.5 provides that, in general, a resource not listed on state or local registers of historical resources shall be considered by the lead agency to be historically significant if the resource meets the criteria for listing on the CRHR. Section 15064.5 also provides standards for determining what constitutes a "substantial adverse change" that must be considered a significant impact on archaeological or historical resources. For example, a "substantial adverse change in the significance of an historical resource means physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired." (State CEQA Guidelines, Cal. Code Regs., tit. 14, § 15064.5, subd. (b)(1).)

Section 15064.5 of the State CEQA Guidelines pertains to the determination of the significance of impacts on archaeological and historical resources. Direct and indirect impacts may occur by any of the following means.

- Physically damaging, destroying, or altering all or part of the resource.
- Altering characteristics of the surrounding environment that contribute to the resource's significance.
- Neglecting the resource to the extent that it deteriorates or is destroyed.
- The accidental discovery of cultural resources during construction.

These could be facilitated through changes in reservoir water surface elevations and river flows that are expected to result from the implementation of each of the LSJR alternatives (discussed in more detail below).

12.4.2 Methods and Approach

LSJR Alternatives

This chapter evaluates the potential cultural resource impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow[6] requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K. Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of no more than 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects on fisheries, including temperature that would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the

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[6] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.

4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cubic feet per second (cfs) may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife.

Cultural resources for this analysis of the LSJR alternatives were identified through a review of the location, environmental setting, and available documentation, as described in Section 12.2, *Environmental Setting*, for the reservoirs and the rivers. No fieldwork was used to confirm the presence or absence of archaeological, architectural, or paleontological resources, and no evaluation of known resources was done to assess their significance. Unless determined previously, the significance evaluation of documented resources will be completed as part of the HPMPs under way for the FERC hydropower water quality certifications for the Don Pedro Project (FERC Project No. 2299) on the Tuolumne River and the Merced River Hydroelectric Project (FERC Project No. 2179), including Lake McClure, or for the RMP administered by USBR at New Melones Lake Area (USBR 2010:5.81; Merced ID 2011: Exhibit E, 334–335; TID and MID 2011b:2-3).

Potential direct and indirect impact mechanisms for disturbing, materially altering, or demolishing cultural resources, including buried human remains and paleontological resources, as a result of the LSJR alternatives were considered. Providing people access to known or currently unknown cultural resources is the primary direct mechanism to disturb, alter, or demolish cultural resources (e.g., vandalism, authorized collection of artifacts, use of off-highway vehicles). Additionally, cultural resources could be indirectly disturbed, altered, or demolished by activities that would substantially increase natural processes (e.g., weathering or erosion). Soil disturbance or grading is not considered a direct impact mechanism because soil disturbance or grading would not occur under the LSJR alternatives. The LSJR alternatives were evaluated by first determining the potential for known and unknown significant cultural resources to exist at the three reservoirs and along the rivers. The results of the State Water Board's Water Supply Effects (WSE) model were then used to qualitatively analyze the effects of altering reservoir elevations or modifying flows.

This chapter presents the quantitative results of the WSE modeling for the specified unimpaired flow requirement of each LSJR alternative (i.e., 20, 40, or 60 percent). This chapter also incorporates a qualitative discussion of adaptive implementation under each of the LSJR alternatives, including the potential environmental effects associated with adaptive implementation. To inform the qualitative discussion and account for the variability allowed by adaptive implementation, modeling was performed to predict conditions at 30 percent and 50 percent of unimpaired flow (as reported in Appendix F.1, *Hydrologic and Water Quality Modeling*). The modeling also allows some inflows to be retained in the reservoirs until after June, as could occur under method 3, to prevent adverse temperature effects. This variety of modeling scenarios provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. This chapter incorporates a qualitative discussion of the potential cultural resource impacts of adaptive implementation under each of the LSJR alternatives. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1.

Reservoir Evaluation

The prevalence of cultural resources, within and adjacent to the reservoirs, determines the potential for direct and indirect impacts on cultural resources. There are documented significant cultural resources located at the reservoirs (see Section 12.2.1, *Reservoir Historic or Archaeological and Paleontological Resources*); however, the locations of many significant or potentially significant cultural resources remain unknown because survey of the reservoirs remains incomplete and there is a potential for buried resources. The LSJR alternatives could reduce reservoir elevations, which could potentially affect cultural resources by: (1) exposing known or currently unknown significant cultural resources now underwater, and (2) providing people access to these resources. Additionally, the LSJR alternatives could substantially increase natural processes (e.g., weathering or erosion) by inundating known or currently unknown significant cultural resources.

WSE model results were summarized in two ways to characterize the effect of the LSJR alternatives on both high and low reservoir elevations in order to assess changes in reservoir elevation that may: (1) increase inundation of cultural resources that are typically out of the water, or (2) increase exposure of cultural resources that are typically below the water surface. These two assessments also capture the change in the range of reservoir elevations. An increase in the range of elevations could result in more resources being within the zones that are repeatedly exposed or inundated.

For the first assessment, the highest elevations under LSJR Alternatives 2, 3, and 4 were identified at the 70, 80, and 90 percent cumulative distribution during June for each alternative, and the difference relative to baseline was calculated (the WSE model results for reservoir storage are end-of-month values). June was selected because during wet years, June is the month with the highest reservoir elevations. Reporting the results of the cumulative distribution accounts for the interannual variability over the 82-year modeled period. The change in high elevations is presented using the 70, 80, and 90 percent cumulative distribution because it is expected that at these elevation levels, cultural resources that typically remain dry would potentially be inundated. Table 12-5 summarizes the results of the 70, 80, and 90 percent cumulative distribution assessment for each reservoir.

Table 12-5. Reservoir Elevations (feet) and Expected Changes (feet) for June at the 70, 80, or 90 Percent Cumulative Distribution for New Melones, New Don Pedro, and Lake McClure

Cumulative Distribution	Baseline Elevations	LSJR Alternative 2 Minus Baseline	LSJR Alternative 3 Minus Baseline	LSJR Alternative 4 Minus Baseline
New Melones	Jun	Jun	Jun	Jun
70%	1,027	8	-6	-38
80%	1,039	5	-9	-33
90%	1,061	4	-11	-28
New Don Pedro				
70%	827	-5	-23	-40
80%	832	-3	-13	-35
90%	833	0	-3	-21
Lake McClure				
70%	861	-3	-23	-42
80%	867	0	-6	-30
90%	867	0	0	-9

Note: Negative numbers indicate a decrease in reservoir elevations; positive numbers indicate an increase in reservoir elevations. The absolute maximum value was not used because it only occurred a few years over the 82-year period, and therefore is not representative of typical conditions.

For the second assessment, the lowest elevations under LSJR Alternatives 2, 3, and 4 were identified at the 10, 20, and 30 percent cumulative distribution for June and September for each alternative, and the difference relative to baseline was calculated. June was selected because the reservoirs typically experience the heaviest use due to recreationists during that time of year, and the LSJR alternatives are most likely to affect reservoir elevations in June. September was selected because it represents the carryover storage at the end of the water year when reservoir levels are often at their lowest level. Reporting the results of the cumulative distribution accounts for the interannual variability over the 82-year modeled period. The change in elevation is presented using the 10, 20, and 30 percent cumulative distribution because it is expected that at these lowest elevation levels, there would be the potential to expose more cultural resources located in the reservoirs. Table 12-6 summarizes the results for each reservoir for the 10, 20, and 30 percent cumulative distribution.

Table 12-6. Reservoir Elevations (feet) and Expected Changes (feet) for June and September at the 10, 20, or 30 Percent Cumulative Distribution for New Melones, New Don Pedro, and Lake McClure

Cumulative Distribution	Baseline Elevations		LSJR Alternative 2 Minus Baseline		LSJR Alternative 3 Minus Baseline		LSJR Alternative 4 Minus Baseline	
New Melones	Jun	Sep	Jun	Sep	Jun	Sep	Jun	Sep
10%	870	837	46	57	47	68	44	72
20%	910	874	31	35	27	45	16	45
30%	941	913	27	25	11	17	2	19
New Don Pedro								
10%	748	706	-1	2	-14	3	-20	13
20%	767	727	1	2	-16	-1	-25	-1
30%	787	744	-3	-2	-26	-10	-33	-8
Lake McClure								
10%	692	636	56	73	37	72	17	69
20%	746	669	23	48	12	50	-2	48
30%	775	701	14	40	2	29	-9	41

Note: Negative numbers indicate a decrease in reservoir elevations; positive numbers indicate an increase in reservoir elevations. The absolute minimum value was not used because it only occurred 1 year over the 82-year period, and therefore is not representative of typical conditions.

River Evaluation

The prevalence of cultural resources within and adjacent to the three eastside tributaries and the LSJR (see Section 12.2.2, *River Historic or Archaeological and Paleontological Resources*) determines the potential for direct and indirect impacts on cultural resources in and adjacent to the rivers. The potential for currently unknown cultural resources to exist is low and many of the known cultural resources have likely been modified, altered, damaged, or destroyed. The expected changes (see below) in flow from the LSJR alternatives would not provide new or expanded access to known or unknown cultural resources. People currently using the rivers would continue to do so and would continue to experience the periodic fluctuations and changes in flow. Therefore, general trends for the LSJR alternatives were identified from the WSE model and used to analyze impacts on cultural resources along the rivers. These trends are summarized below.

- For LSJR Alternative 2, modeled monthly flows on the Stanislaus River were generally similar to baseline flows, although with some small shifting of flows from March to June. Flows for the Tuolumne and Merced Rivers and the LSJR were generally similar to or greater than baseline flows, depending on the month (Tables 5-16 and 5-17a, 5-17b, 5-17c, and 5-17d).
- For LSJR Alternatives 3 and 4, modeled monthly flows would generally increase relative to baseline flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR (Table 5-16 and 5-17a, 5-17b, 5-17c, and 5-17d). In most cases, these rivers would experience substantial increases in median flows from February–June relative to baseline.
- For LSJR Alternatives 3 and 4, modeled results indicated occasional reductions in the highest flows caused by a reduced need for flood control releases when compared to baseline conditions. Flood control releases were most likely to occur when the reservoirs were filling

with storm flows or when the reservoirs had to be emptied in the fall in preparation for storms in winter and spring. Flood control releases occurred more often in wet years and were more common at New Don Pedro Reservoir and Lake McClure (i.e., the two smaller reservoirs). During wet years, reservoir releases were greater under LSJR Alternatives 3 and 4, so reservoir storage would reach the maximum allowed limit less often, and flood control releases would not be needed as much.

- The largest changes in flow associated with the LSJR alternatives occurred from February–June, but there were some smaller effects outside of this period. Changes from July–January were primarily related to changes in flood control releases, retention of unimpaired flow for later release in the fall as part of adaptive implementation described under the LSJR alternatives in Section 12.4.3, *Impacts and Mitigation Measures*, during wet conditions, and retention of water in the reservoirs to maintain carryover storage (by reducing diversions in dry years).

As described in Chapter 3, *Alternatives Description*, the percent of unimpaired flow, as specified by the LSJR alternatives, would not apply when such flows would cause flooding or other related public safety concerns.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, and Appendix B, *State Water Board's Environmental Checklist*, the baseline water quality in the southern Delta generally ranges from 0.2 deciSiemens per meter (dS/m)[7] and 1.2 dS/m during all months of the year. Under SDWQ Alternatives 2 or 3, salinity levels in the southern Delta are expected to remain within their historical range (i.e., 0.2 dS/m–1.2 dS/m) because the salinity in the southern Delta has a strong relationship with the salinity at Vernalis, and the program of implementation for SDWQ Alternatives 2 or 3 would still include requirements for USBR to maintain salinity at Vernalis in accordance with its water rights. Therefore, the chemical properties of the baseline water quality conditions in the southern Delta (identified in Chapter 5, *Surface Hydrology and Water Quality*) would not change, and would have no potential to cause a substantial adverse change in the significance of historical or archaeological resources, to disturb human remains, including those interred outside formal cemeteries, or to directly or indirectly destroy a unique paleontological resource, site or unique geologic feature. Therefore, impacts on historical resources, archaeological resources, human remains, or unique paleontological resources under the SDWQ alternatives are not further discussed

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[7] In the 2006 Bay-Delta Plan, a salinity value—or electrical conductivity (EC) value—of 2.64 millimhos/centimeter (mmhos/cm) is used to represent the X2 location. X2 is the location of the 2 parts per thousand salinity contour (isohaline), 1 meter off the bottom of the estuary measured in kilometers upstream from the Golden Gate Bridge. Note, in this SED, EC is generally expressed in deciSiemens per meter (dS/m). The conversion is 1 mmhos/cm = 1 dS/cm.

in this chapter. To comply with specific water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on cultural resources. These impacts are evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

12.4.3 Impacts and Mitigation Measures

Impact CUL-1: Cause a substantial adverse change in the significance of a historical or archaeological resource

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 *Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan). See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

There is generally a high potential for currently known and unknown significant cultural resources to exist at the three reservoirs because some resources have already been documented at each of the reservoirs. As described in Section 12.2, *Environmental Setting*, two-thirds of the documented cultural resources at New Melones Reservoir are currently located in the permanent pool zone and/or the fluctuation pool zone. Few cultural resources have been documented below the average water level at New Don Pedro Reservoir. Documented archaeological sites and one built resource at Lake McClure are at or below the high water levels and currently experience inundation by water or exposure by receding water. Significant historical and archaeological resources (historic properties) are protected and managed under the HPMPs as part of the FERC hydropower water quality certifications for the Don Pedro Project (FERC Project No. 2299) on the Tuolumne River and the Merced River Hydroelectric Project (FERC Project No. 2179), including Lake McClure, and by the RMP administered by USBR at New Melones Reservoir.

There is a low potential for unknown significant cultural resources to exist on the three eastside tributaries and the LSJR because of prior disturbance by agriculture, irrigation practices, mining activities, or development within the riverine floodplains. Since the rivers have experienced extensive disturbances since the start of the historic period approximately 150 years ago, there is a low potential for unknown significant cultural resources to exist within the displaced or reworked soils or sediments in the confined river channels. Furthermore, although a high number of historic period archaeological sites or built resources have been recorded along the rivers, many have been highly disturbed or destroyed by these processes as the natural floodplains and terraces were modified and confined by levees or agricultural fields, or as early settlements or mining prospects were later displaced or buried by hydraulic mining and dredging, which continued into the mid-1900s in some places, such as the Lower Tuolumne River near Waterford, and then by modern large-scale aggregate mining (see Section 12.2.2, *River Historic or Archaeological and Paleontological Resources*).

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Reservoirs

LSJR Alternative 2 would change reservoir elevations in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure. Table 12-5 and Table 12-6 summarize the expected changes. In general, under LSJR Alternative 2 there would be little change in the highest reservoir elevations in June (Table 12-5); there would be slight increases in New Melones Reservoir (less than 10 ft), and slight decreases in New Don Pedro Reservoir and Lake McClure (5 ft or less). Under LSJR Alternative 2, the lower reservoir elevations in September (Table 12-6) are expected to increase significantly at New Melones Reservoir (25–57 ft) and would be similar to baseline at New Don Pedro Reservoir. At Lake McClure, the very lowest reservoir elevations (10 percent cumulative distribution) would increase by 73 ft under LSJR Alternative 2 as a result of the LSJR alternative carryover storage requirements; moderately low elevations (30 percent cumulative distribution) would increase under LSJR Alternative 2 by 40 ft in September (Table 12-6).

Depending on the location at New Melones Reservoir, cultural resources could experience slight increases in inundation at high reservoir elevations under LSJR Alternative 2. However, while inundation might increase, higher water surface elevations would be expected to prevent human disturbance, and siltation could provide protection to existing cultural resources from human disturbance and other physical forces. Furthermore, under LSJR Alternative 2, the lowest elevations at the reservoirs are expected to be either similar to baseline or be above baseline elevations. The carryover storage requirement means that in some cases, cultural resources that occasionally were exposed during droughts under baseline conditions might no longer be exposed.

The existing archaeological and historic-era built environment resources currently experience, and would continue to experience, fluctuations in water levels at the reservoirs. Furthermore, the management plans for historic properties at the reservoirs would include standard unanticipated discovery and treatment measures should any previously unknown significant cultural resources be discovered during continued operation of the dams. Therefore, while cultural resources might experience variation in their physical environment due to changes in water level or siltation, these variations have an extremely low potential to cause a substantial adverse change in the characteristics that convey the historical significance of the resources. As such, under LSJR Alternative 2, impacts on historical or archaeological resources at the reservoirs would be less than significant.

Rivers

The potential for vandalism, unauthorized collection, and other anthropogenic disturbances is considered low along the LSJR and the three eastside tributaries because of the prior anthropogenic and natural disturbance of the rivers and adjacent areas. It is expected that each of the rivers would continue to experience episodic high flows during significant storm events as the flood capacities of the rivers are controlled and managed by USACE. LSJR Alternative 2 would not exceed flood control or management requirements. Furthermore, average and seasonal flows are expected to remain within the existing channels that have been previously disturbed by natural flows and anthropogenic activities. The potential for bank erosion on all four rivers under this alternative is expected to be similar to baseline conditions, including the occasional years with major flood events. Given the low potential for significant cultural resources to be located within and adjacent to the rivers, and because the expected change in flows has an extremely low potential to cause a substantial adverse change in the characteristics that convey the historical significance of any resources that may be present, impacts on historical or archaeological resources located within or adjacent to the rivers under LSJR Alternative 2 would be less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June timeframe. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent.

Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. WSE model results show that under LSJR Alternative 2 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and the LSJR only 2.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required 0.7 percent of the time to meet a 1,000-cfs requirement and 0.5 percent of the time for an 800-cfs Vernalis base flow requirement. These results indicate that changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR.

Impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3. With method 1, if the specified percent of unimpaired flow were changed from 20 percent to 30 percent on a long-term basis, the conditions and impacts could become more similar to those described under LSJR Alternative 3 (e.g., 30 percent unimpaired flow). It is anticipated that over time the unimpaired flow requirement could increase or not change at all within a year or between years, depending on hydrology, and fish and wildlife conditions. If method 2 is implemented, the total annual volume of water associated with LSJR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change. As a result, the total volume of water that would remain in the river would not change with adaptive implementation method 2. However, given that this method would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, and given the prior anthropogenic and natural disturbance of the rivers and adjacent areas have resulted in a low potential for significant historical or archaeological resources to exist, impacts would be similar to those described above under LSJR Alternative 2. Implementing method 4 is expected to have little effect on conditions in the three eastside tributaries and the LSJR because it would rarely cause a change in flow and the volume of water involved would be relatively small. Consequently the impact determination of LSJR Alternative 2 with adaptive implementation for historical or archaeological resources would be the same as described above under LSJR Alternative 2 without adaptive implementation. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Reservoirs

LSJR Alternative 3 would change reservoir elevations in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure. Table 12-5 and Table 12-6 summarize the expected changes. In general, under LSJR Alternative 3, there would be slight decreases in the highest reservoir elevations, with the largest decrease (23 ft) occurring at the 70 percent cumulative distribution level at New Don Pedro Reservoir and Lake McClure (Table 12-5). Under LSJR Alternative 3, the lower reservoir elevations in September (Table 12-6) are expected to increase significantly at New Melones Reservoir (31–83 ft) and would be similar to baseline at New Don Pedro Reservoir. At Lake McClure, the very lowest reservoir elevations in September would increase under LSJR Alternative 3 (by 72 ft) as a result of carryover storage requirements that are part of LSJR Alternative 3, and the moderately low elevations (30 percent cumulative distribution) would increase by 29 ft. Similarly, at New Melones Reservoir, the very lowest reservoir elevations in September would increase under LSJR Alternative 3 (by 68 ft) as a result of carryover storage requirements that are part of LSJR Alternative 3, and the moderately low elevations (30 percent cumulative distribution) would increase by 17 ft. For instances in which LSJR Alternative 3 may reduce already low reservoir elevations, the reduction relative to baseline is greater in June than it is in September (Table 12-6). These reductions in elevation during a period of high recreational use (June) could expose cultural resources to more human-caused damage. However, actual elevations in June are significantly higher than in September. Exposure of some resources in June under LSJR Alternative 3 would not be consequential, given that the resources would ultimately be exposed by September under baseline conditions.

Under LSJR Alternative 3, resources high in the fluctuation pool zone may experience slightly less inundation. Furthermore, under LSJR Alternative 3, the lowest elevations at the reservoirs are expected to be either similar to baseline or be above baseline elevations. The carryover storage requirement for LSJR Alternative 3 means that in some cases, cultural resources that occasionally were exposed during droughts under baseline conditions might no longer be exposed. Cultural resources would continue to experience inundation and receding reservoir water levels.
As described under LSJR Alternative 2, any documented or currently unknown significant cultural resource would be managed by the various plans of the reservoirs (e.g., the New Melones Lake RMP and Resource Protection Plan, and the HPMPs for New Don Pedro and Lake McClure). Although cultural resources might experience variation in their physical environment due to changes in water level or siltation, these variations have an extremely low potential to cause a substantial adverse change in the characteristics that convey the historical significance of the resources. Therefore, under LSJR Alternative 3, impacts on historical or archaeological resources at the reservoirs would be less than significant.

Rivers

As discussed under LSJR Alternative 2, there is a low potential for unknown significant cultural resources to be located within and adjacent to the rivers due to past anthropogenic and natural modifications within river channels and adjacent to river channels. Under LSJR Alternative 3, average and seasonal flows are expected to remain within the existing channels, which have been previously disturbed by natural flows and anthropogenic activities. Furthermore, there is only a low potential for significant cultural resources to be located within or adjacent to the rivers, and the expected change in flows has an extremely low potential to cause a substantial adverse change in the characteristics that convey the historical significance of any resources that may be present. Therefore, impacts on historical or archaeological resources located within or adjacent to the rivers under LSJR Alternative 3 would be less than significant.

Adaptive Implementation

Under LSJR Alternative 3, impacts associated with adaptive implementation method 1 may be slightly different from those associated with adaptive implementation methods 2 and 3.

Implementing method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40 percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. Adaptive implementation method 1 could affect the volume of water and level of flow in the LSJR and its tributaries. However, the frequency and duration of such a change is unknown. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent, or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively. It is anticipated that over time the unimpaired flow requirement could increase, decrease, or not change at all within a year or between years, depending on hydrology, and fish and wildlife conditions.

Under adaptive implementation methods 2 or 3, the overall volume of water from the February–June time period or after June would be the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. Adaptive implementation method 3 is incorporated into the modeling; thus, the range of historical or archaeological effects is reflected in the results presented above under LSJR Alternative 3. Furthermore, given that these two methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, and given that prior anthropogenic and natural disturbance of the rivers and adjacent areas have resulted in a low potential for significant historical or archaeological resources to exist, impacts would be similar to those described above under LSJR Alternative 3.

Implementing method 4 is expected to have little effect on conditions in the three eastside tributaries and the LSJR. WSE model results show that under LSJR Alternative 3 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and the LSJR only 1.2 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required only 0.2 percent of the time to meet either a 1,000-cfs or 800-cfs Vernalis base flow requirement. These results indicate that adaptive implementation method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative.

Consequently, the impact determination of LSJR Alternative 3 with adaptive implementation would be the same as described above under LSJR Alternative 3 without adaptive implementation, for historical or archaeological resources. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Reservoirs

LSJR Alternative 4 would change reservoir elevations in New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure. Table 12-5 and Table 12-6 summarize the expected changes. In general, under LSJR Alternative 4, there would be decreases in the highest reservoir elevations, with all three reservoirs experiencing a roughly 40 foot decrease in carryover elevations at the 70 percent cumulative distribution level (Table 12-5). Under LSJR Alternative 4, the lower reservoir elevations (in September), are expected to increase significantly at New Melones Reservoir (19–72 ft) and at Lake McClure (41–69 ft) (Table 12-6). At New Don Pedro Reservoir, elevations in September would be similar to baseline with changes in elevation ranging from a decrease of 8 ft (30 percent cumulative distribution) to an increase of 13 ft (10 percent cumulative distribution) (Table 12-6). LSJR Alternative 4 is more likely to cause low elevations relative to baseline in June than in September (Table 12-6). These reductions in elevation during a period of high recreational use (June) could expose cultural resources to more human-related damage. However, actual elevations in June are significantly higher than in September. Exposure of some cultural resources in June under LSJR Alternative 4 would not be consequential, given that the resources would ultimately be exposed by September under baseline conditions.

Under LSJR Alternative 4, resources high in the fluctuation pool zone may experience less inundation. Furthermore, under LSJR Alternative 4, the lowest elevations at the reservoirs are expected to be either similar to baseline or be above baseline elevations. The carryover storage requirement for LSJR Alternative 4 means that in some cases, cultural resources that occasionally were exposed during droughts under baseline conditions might no longer be exposed. Cultural resources would continue to experience inundation and receding reservoir waters. As discussed under LSJR Alternative 2, cultural resources would be managed by the various plans of the reservoirs (e.g., the New Melones Lake RMP and Resource Protection Plan, and the HPMPs for New Don Pedro and Lake McClure). Although cultural resources might experience variation in their physical environment due to changes in water level or siltation, these variations have an extremely low potential to cause a substantial adverse change in the characteristics that convey the historical significance of the resources. Therefore, under LSJR Alternative 4, impacts on historical or archaeological resources at the reservoirs would be less than significant.

Rivers

There is a low potential for unknown significant cultural resources to be located within and adjacent to the rivers due to past anthropogenic and natural modifications within river channels and adjacent to river channels. As discussed under LSJR Alternative 2, any modification of flows has an extremely low potential to cause a substantial adverse change in the characteristics that convey the historical significance of documented or currently undocumented historical or archaeological resources located within or adjacent to the rivers. Therefore, impacts on historical or archaeological resources within or adjacent to the rivers under LSJR Alternative 4 would be less than significant.

Adaptive Implementation

Under LSJR Alternative 4, impacts associated with adaptive implementation method 1 may be slightly different from those associated with methods 2 and 3.

Implementing method 1 would allow a decrease of up to 10 percent in the annual February–June 60 percent unimpaired flow (to a minimum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3. It is anticipated that over time the unimpaired flow requirement could decrease or not change at all within a year or between years, depending on hydrology, and fish and wildlife conditions.

Under adaptive implementation methods 2 or 3, the overall volume of water from the February–June time frame or after June would be the same as under LSJR Alternative 4 without adaptive implementation, but the volume within each month could vary. Adaptive implementation method 3 is incorporated into the modeling; thus, the range of historical or archaeological effects is reflected in the results presented above under LSJR Alternative 4. Furthermore, given that these two methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, and given the prior anthropogenic and natural disturbance of the rivers and adjacent areas have resulted in a low potential for significant historical or archaeological resources to exist, impacts would be similar to those described above under LSJR Alternative 4.

Implementing method 4 is expected to have little effect on conditions in the three eastside tributaries and the LSJR. WSE model results show that under LSJR Alternative 4 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and the LSJR only 0.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required only 0.2 percent of the time to meet a 1,000-cfs requirement and is not affected at all for an 800-cfs requirement. These results indicate that adaptive implementation method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative.

Consequently, the impact determination of LSJR Alternative 4 with adaptive implementation would be the same as described above under LSJR Alternative 4 without adaptive implementation, for historical or archaeological resources. Impacts would be less than significant.

Impact CUL-2: Disturb any human remains, including those interred outside formal cemeteries

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the*

No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1), for the No Project Alternative technical analysis.

LSJR Alternatives

As described in Section 12.2, *Environmental Setting*, human remains interred outside of formal cemeteries have been documented at relatively few archaeological sites at New Melones Reservoir and New Don Pedro Reservoir. No human remains have been documented to date at Lake McClure. Cemeteries have been documented at New Melones Reservoir; however, "cemetery" is not listed as a historic site type at New Don Pedro Reservoir or Lake McClure. Furthermore, no evidence of burials was found at a possible cemetery at Lake McClure. In compliance with procedures for the treatment of human remains discovered on state, private, or federal lands, documented human remains would have been left in place, reinterred under the maximum pool or elsewhere, or excavated, curated, and/or repatriated at each of the reservoirs if they had been discovered previously. In addition, documented or currently undocumented sites with human remains would be protected under federal and state laws and under the HPMPs for the New Don Pedro on the Tuolumne River and Lake McClure, and by the RMP administered by USBR at New Melones Reservoir. The potential for the presence of human remains in proximity to the reservoir fluctuation zones is considered low.

The potential for the presence of undocumented human remains within and adjacent to the LSJR and the three eastside tributaries is considered low due to prior disturbance of the riparian corridors by natural and historic-era anthropogenic processes. Any human remains discovered within and adjacent to the LSJR and the three eastside tributaries outside of formal cemeteries would also have been treated in accordance with state or federal regulations.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Reservoirs and Rivers

Since the potential for human remains to exist within the fluctuation zone of the reservoirs is low, the change in reservoir elevation described above in Impact CUL-1 would have a low potential to disturb documented or undocumented human remains. Considering the prior disturbance by agriculture, irrigation practices, mining activities, and development within the riverine floodplains, the change in flows under LSJR Alternative 2 would have an extremely low potential to disturb documented or undocumented human remains, including those interred outside formal cemeteries. The natural processes of localized soil erosion and siltation could also be beneficial by reducing the potential for access and unauthorized artifact collection or vandalism. Therefore, under LSJR Alternative 2, impacts on human remains, including those interred outside formal cemeteries, would be less than significant.

Adaptive Implementation

It is anticipated that adaptive implementation would not substantially change the less than significant determination for impacts on human remains. As discussed under Impact CUL-1, it is anticipated that over time the unimpaired flow requirement could increase or not change at all within a year or between years, depending on hydrology, and fish and wildlife conditions under adaptive implementation method 1. If method 2 is implemented, the total annual volume of water associated with LJSR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change. As a result, the total volume of water that would remain in the river would not change with adaptive implementation method 2; therefore, impacts associated with total volume of water would not change. Given that this method would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described under LSJR Alternative 2 without adaptive implementation. Implementing method 4 is expected to have little effect on conditions in the three eastside tributaries and the LSJR because it rarely would cause a change in flow and the volume of water involved would be relatively small. Consequently, the impact determination of LSJR Alternative 2 with adaptive implementation would be the same as described above under LSJR Alternative 2 without adaptive implementation, for human remains. Impacts would be less than significant.

LSJR Alternatives 3 and 4 (Less than significant/Less than significant with adaptive implementation)

For LSJR Alternatives 3 and 4, the impacts on human remains, including those interred outside formal cemeteries, would not differ from those described under LSJR Alternative 2, with and without adaptive implementation methods 1, 2, and 4. Under adaptive implementation method 3, the overall volume of water from the February–June time period or after June would be the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. However, adaptive implementation method 3 is incorporated into the modeling; thus, the range of impacts on human remains is reflected in the results described above under LSJR Alternatives 3 and 4 under Impact CUL-1. In addition, given that these methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described for LSJR Alternative 3 and 4. Therefore, impacts on human remains under LSJR Alternatives 3 and 4 with and without adaptive implementation would be less than significant.

Impact CUL-3: Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis*.*

LSJR Alternatives

As described in Section 12.2, *Environmental Setting*, the rock units in proximity to the reservoirs have a low potential to contain paleontological resources. No paleontological resources have been documented at New Don Pedro Reservoir or Lake McClure. At New Melones Reservoir, fossils were recovered from more than 12 caves. More than 50 caves at New Melones Reservoir are inundated or subject to inundation. Three of the caves subject to inundation are considered significant paleontological resources. The documented caves are protected and managed under the Cave Management Plan administered by USBR at New Melones Reservoir.

As also described in Section 12.2, *Environmental Setting*, the potential for paleontological resources within and adjacent to the LSJR and the three eastside tributaries is considered low due to the depth of occurrence of rock units with high paleontological potential below reworked surficial sediments and Holocene-age floodplain and channel deposits. In other words, buried paleontological resources would be found at soil and rock depth too deep for the rivers to modify or change. The potential is also low due to disturbance or destruction of near-surface paleontological resources by historic-era anthropogenic practices or natural processes.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Reservoirs

As described above under Impact CUL-1, reservoir elevations currently experience, and would continue to experience, fluctuations in water levels at the reservoirs (Table 12-5 and 12-6). No paleontological resources have been documented at New Don Pedro Reservoir or Lake McClure. The low potential for rock units within proximity of these two reservoirs indicates that the change in elevation under LSJR Alternative 2 would have a low potential to affect any unknown paleontological resources. New Melones Reservoir may experience an increase in reservoir elevations. Many of the caves adjacent to the reservoir are currently above the spillway elevation, and of those that are below the spillway elevation, the increase in reservoir elevations could prevent human disturbance of the caves. The documented caves would continue to be protected and managed under the Cave Management Plan, which is administered by USBR at New Melones Reservoir. Therefore, under LSJR Alternative 2, impacts on paleontological resources or sites or unique geologic features associated with the reservoirs would be less than significant.

Rivers

The expected change in flows in the LSJR and the three eastside tributaries would have an extremely low potential to disturb paleontological resources. This is because these resources are typically identified at depths below the surficial sediments reworked by historic-era anthropogenic practices and the Holocene-age floodplain and channel deposits along the riparian corridors. In addition, it is likely that near-surface paleontological resources have been previously disturbed or destroyed by agriculture, irrigation practices, mining activities, or other development. Therefore, impacts on paleontological resources or sites or unique geologic features under LSJR Alternative 2 associated with the rivers would be less than significant.

Adaptive Implementation

It is anticipated that adaptive implementation would not substantially change the less than significant determination for impacts on paleontological or geologic features. As discussed under Impact CUL-1, it is anticipated that over time the unimpaired flow requirement could increase or not change at all within a year or between years, depending on hydrology, and fish and wildlife conditions, under method 1. If method 2 is implemented, the total annual volume of water associated with LJSR Alternative 2 (i.e., 20 percent of the February–June unimpaired flow) would not change. As a result, the total volume of water that would remain in the river would not change with adaptive implementation method 2. Given that this method would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described under LSJR Alternative 2. Implementing method 4 is expected to have little effect on conditions in the three eastside tributaries and the LSJR because it rarely would cause a change in flow and the volume of water involved would be relatively small. Consequently the impact determination of LSJR Alternative 2 with adaptive implementation would be the same as described above under LSJR Alternative 2 without adaptive implementation, for paleontological or geologic features. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

Reservoirs

Impacts for LSJR Alternative 3 would be the same as described above under LSJR Alternative 2 for New Don Pedro Reservoir and Lake McClure. At New Melones Reservoir, the highest reservoir elevations may decrease (Table 12-5) and the lowest reservoir elevations may increase (Table 12-6). This reduction in the range of elevations could reduce the potential to adversely affect the caves by natural processes such as erosion and weathering and/or could reduce access to the caves and the risk of vandalism or unauthorized collection of undocumented, newly eroded fossils. The documented caves would continue to be protected and managed under the Cave Management Plan, administered by USBR at New Melones Reservoir. Therefore, under LSJR Alternative 3, impacts on paleontological resources or sites or unique geologic features would be less than significant.

Rivers

Impacts for LSJR Alternative 3 would be the same as described above under LSJR Alternative 2 for the three eastside tributaries and the LSJR. Therefore, impacts on paleontological resources or sites or unique geologic features would be less than significant.

Adaptive Implementation

It is anticipated that adaptive implementation would not substantially change the less than significant determination for impacts on paleontological or geologic features. Adaptive implementation method 1 could affect the volume of water and level of flow in the LSJR and its tributaries. However, the frequency and duration of such a change is unknown. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 or 4, respectively. It is anticipated that over time the unimpaired flow requirement could increase, decrease, or not change at all within a year or between years, depending on hydrology, and fish and wildlife conditions.

Under adaptive implementation methods 2 or 3, the overall volume of water from the February–June time frame or after June would be the same as LSJR Alternative 3 without adaptive implementation, but the volume within each month could vary. However, given that these two methods would not allow flows to go below what is required by existing requirements on the three eastside tributaries and the SJR, impacts would be similar to those described above under LSJR Alternative 3. Implementing method 4 is expected to have little effect on conditions in the three eastside tributaries and WSE model results indicate that method 4 would rarely alter the flows in the three eastside tributaries or the LSJR under this alternative. Consequently, the impact determination of LSJR Alternative 3 with adaptive implementation would be the same as described above under LSJR Alternative 3 without adaptive implementation, for paleontological or geologic features. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

Impacts for LSJR Alternative 4 would be the same as described above under LSJR Alternative 2 for New Don Pedro Reservoir and Lake McClure. Impacts would be the same as described above under LSJR Alternative 3 for New Melones Reservoir. Impacts would be the same as described above under LSJR Alternative 2 for the three eastside tributaries and the LSJR. Therefore, under LSJR Alternative 4 with and without adaptive implementation, impacts on paleontological resources or sites or unique geologic features would be less than significant.

12.4.4 Impacts and Mitigation Measures: Extended Plan Area

Cultural resources in the extended plan area could be affected by the bypassing of flow, as described in Chapter 5, *Surface Hydrology and Water Quality*. Bypassing flows could produce increased stream flows downstream of the reservoirs during the bypass period, or lower flows after the bypass period, and could produce lower reservoir levels. Effects on significant cultural resources could occur if existing significant cultural resource sites at these locations were exposed to increased erosion or other physical conditions resulting in deterioration. Additionally, sites exposed by lower reservoir levels could be vulnerable to discovery, disturbance, and artifact removal. However, both the river flow and reservoir level reductions would be similar to reductions under baseline conditions, although they could occur more frequency. Furthermore, because these reductions have occurred under baseline conditions, existing significant cultural resources have already been affected. Lastly, under the LSJR alternatives with or without adaptive implementation, erosion or exposure of existing significant cultural resources is not expected to be substantially different than under baseline conditions. Consequently, impacts on significant cultural resources under the LSJR alternatives with or without adaptive implementation would be less than significant in the extended plan area.

12.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 13
Service Providers

13.1 Introduction

This chapter describes the environmental setting for service providers and the regulatory background associated with service providers. This chapter also evaluates the environmental impacts on service providers that could result from the Lower San Joaquin River (LSJR) and southern Delta water quality (SDWQ) alternatives, and, if applicable, offers mitigation measures that would reduce or avoid any significant impacts.

This chapter describes the potential impacts of the LSJR and SDWQ alternatives associated with service providers within the area of potential effects, which includes: the plan area, as described in Chapter 1, *Introduction*; the Eastern San Joaquin, Modesto, Turlock, and Merced[1] Subbasins; and other areas outside the plan area with service providers that are affected by the alternatives. Service providers discussed in this chapter are public providers of water supply for municipal, industrial, and agricultural uses, and providers of wastewater treatment. Private wells that provide domestic water supply are also included in this chapter.

The extended plan area, also described in Chapter 1, *Introduction,* generally includes the area upstream of the rim dams.[2] The area of potential effects for this area would be service providers in this area relying on surface water diversions from the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the area of potential effects below the rim dams. Where appropriate, the extended plan area is specifically identified.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Resources Control Board (State Water Board) evaluated whether the plan amendments[3] would cause any adverse impact on resources in each of the listed environmental categories and provided a brief explanation for its determinations. It determined that impacts on public services (e.g., fire protection, police protection, schools, parks) and some impacts associated with utilities and service systems (e.g., stormwater drainage facilities, landfills) were either less than significant or had no impact. Impacts in the checklist that are identified as "Potentially Significant Impacts" under utilities and service systems or hydrology and water quality are discussed in detail in this chapter.

The State Water Board focuses the impact analysis in this chapter on specific issues associated with the LSJR and SDWQ alternatives that are related to potentially significant impacts identified in Appendix B (i.e., XVII b and IX a). The impacts listed below in Table 13-1 are specific to the LSJR and SDWQ alternatives; they are modified, as appropriate, from the impacts listed in Appendix B to be more relevant to effects that may occur in association with the alternatives. Particularly, they are

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[1] As described in Chapter 9, *Groundwater Resources*, the Merced Subbasin was extended for the analysis to include a part of the Chowchilla Subbasin, creating the *Extended Merced Subbasin*.

[2] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

[3] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

modified to address effects associated with potential reductions in surface water supply to service providers. Accordingly this chapter evaluates whether the LSJR and SDWQ alternatives would: (1) require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects, and (2) violate any water quality standards such that drinking water quality from (a) public water systems and (b) domestic wells would be affected.[4] Additionally, this chapter evaluates if the LSJR alternative would result in substantial changes to San Joaquin River (SJR) inflows to the Delta such that insufficient water supplies would be available to service providers relying on Central Valley Project (CVP)/State Water Project (SWP) exports. This is because changes to SJR inflow into the southern Delta resulting from the LSJR alternatives could change exports to service providers in the export service areas (i.e., CVP and SWP contractors) since some the inflow from the LSJR is exported at the CVP and SWP pumps to the export service areas. Section 13.4, *Impact Analysis*, describes the significance thresholds for determining whether a potential impact associated with service providers is significant.

A summary of the potential impacts of the LSJR and SDWQ alternatives on service providers is provided in Table 13-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 each include four methods of adaptive implementation. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 13-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR/SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* More information and analysis regarding the environmental impacts associated with the construction and/or operation of water treatment facilities or water supply infrastructure or other actions that may be taken by service providers in response to implementation of the plan amendments are discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

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[4] As stated in Appendix B, *State Water Board's Environmental Checklist*, the LSJR Alternatives would change the volume of water in existing reservoirs and rivers and would not result in a violation of waste discharge requirements (WDRs). The SDWQ Alternatives 2 and 3 would articulate the water quality objective (i.e., standard) for salinity, from which requirements in WDRs would be derived; therefore, they would not violate WDRs. Thus, this chapter does not further discuss violations of WDRs.

Table 13-1. Summary of Service Provider Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact SP-1: Require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Significant	NA
LSJR Alternative 2	Average surface water diversions on the Stanislaus, Tuolumne, and Merced Rivers would be reduced by 2 percent, 2 percent, and 6 percent, respectively, compared to baseline conditions. Further, there would not be a substantial depletion of groundwater supplies; therefore, it is not expected that service providers or public water suppliers would need to construct or operate new water supply or wastewater treatment facilities or expand existing facilities. However, if adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20 percent up to 30 percent), it is expected that there would be a substantial reduction of surface water on the Merced and Tuolumne Rivers and a substantial depletion of groundwater supplies in the Extended Merced Subbasin. These reductions would potentially require service providers to construct new and expanded water supply or wastewater treatment facilities, the construction of which could result in significant environmental effects.	Less than significant	Significant and unavoidable[c]
LSJR Alternative 3	Surface water diversion reductions on the Stanislaus, Tuolumne, and Merced Rivers are expected to be approximately 12 percent, 14 percent and 16 percent, respectively. Further, as a result of the substantial reduction of surface water supply on the rivers, it is expected that there would be a substantial depletion of groundwater supplies in the Modesto, Turlock, and Extended Merced Subbasins. These reductions would potentially require service providers to construct new and expanded water supply or wastewater treatment facilities, the construction of which could result in significant environmental effects.	Significant and unavoidable	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternative 4	Surface water diversion reductions on the Stanislaus, Tuolumne, and Merced Rivers are expected to be approximately 32 percent, 35 percent, and 32 percent, respectively. Further, as a result of the substantial reduction of surface water supply on the rivers, it is expected that there would be a substantial depletion of groundwater supplies in the Eastern San Joaquin, Modesto, Turlock, and Extended Merced Subbasins. These reductions would potentially require service providers to construct new and expanded water supply or wastewater treatment facilities, the construction of which could result in significant environmental effects.	Significant and unavoidable	Significant and unavoidable
SDWQ Alternative 2	The Cities of Stockton and Tracy, and Mountain House CSD, may need to construct new wastewater treatment facilities or expand existing facilities to comply with potential changes to NPDES effluent limitation implementing a 1.0 dS/m salinity objective, the construction of which could result in significant environmental effects.	Significant and unavoidable	NA
SDWQ Alternative 3	The construction of new wastewater treatment facilities is not expected in order to comply with changes to NPDES effluent limitations implementing a 1.4 dS/m objective for salinity. As such, construction would not occur and would not result in significant environmental effects.	Less than significant	NA

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact SP-2a: Violate any water quality standards such that drinking water quality from public water systems would be affected			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternative 2	Because service providers and irrigation districts relying primarily on surface water would not need to supplement their supply with groundwater under LSJR Alternative 2, there would likely be no degradation of groundwater quality. If an increase in the February–June percent of unimpaired flow from 20 percent up to 30 percent were implemented on a long-term basis, increased groundwater pumping and reductions in groundwater levels in the Extended Merced Subbasin could affect groundwater quality. However, a substantial increase in groundwater pumping would not necessarily result in violation of water quality standards for drinking water because recent data do not indicate increased water quality standard violations in public water systems despite greatly increased groundwater pumping, and if a drinking water quality problem is detected, action would be taken (as covered under Impact SP-1) to improve water quality. Therefore, impacts would be less than significant. During some months, salinity in the SJR at Vernalis and in the southern Delta channels may increase slightly, but on average, salinity is expected to be reduced; therefore, a substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur, and impacts would be less than significant.	Less than significant	Less than significant
LSJR Alternatives 3 and 4	As a result of increased groundwater pumping, reductions in groundwater levels in the Modesto, Turlock, and Extended Merced Subbasins under LSJR Alternative 3, and also in the Eastern San Joaquin Subbasin under LSJR Alternative 4 with adaptive implementation method 1 could affect groundwater quality. However, a substantial increase in groundwater pumping would not necessarily result in an increase in violation of water quality standards for drinking water because recent data do not indicate increased water quality standard violations in public water systems despite greatly increased	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
	groundwater pumping, and if a drinking water quality problem is detected, action would be taken (as covered under Impact SP-1) to improve water quality. Salinity in the SJR at Vernalis and in the southern Delta channels is expected to be reduced; therefore, a substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur. Therefore, impacts would be less than significant.		
SDWQ Alternatives 2 and 3	The USBR water rights permits will continue to include requirements to meet the current 0.7 EC April–August Vernalis salinity standard, as contained in the program of implementation. This would maintain the historical range of salinity in the southern Delta. Therefore, a substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur.	Less than significant	NA
Impact SP-2b: Violate any water quality standards such that drinking water quality from domestic wells would be affected[c]			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA
LSJR Alternative 2	Because service providers and irrigation districts relying primarily on surface water would not need to supplement their supply with groundwater under LSJR Alternative 2, there would likely be no degradation of groundwater quality. If an increase in the February–June percent of unimpaired flow from 20 percent up to 30 percent were implemented on a long-term basis, increased groundwater pumping and reductions in groundwater levels in the Extended Merced Subbasin could affect groundwater quality. Domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. There is no required mechanism to prevent private domestic wells from using groundwater that may exceed MCLs. Therefore, impacts would be significant under LSJR Alternative 2, with adaptive implementation.	Less than significant	Significant and unavoidable

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternatives 3 and 4	As a result of increased groundwater pumping, reductions in groundwater levels in the Modesto, Turlock, and Extended Merced Subbasins under LSJR Alternative 3, and also in the Eastern San Joaquin Subbasin under LSJR Alternative 4 with adaptive implementation method 1 could affect groundwater quality. Domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. There is no required mechanism to prevent private domestic wells from using groundwater that may exceed MCLs. Therefore, impacts would be significant.	Significant and unavoidable	Significant and unavoidable
Impact SP-3: Result in substantial changes to SJR inflows to the Delta such that insufficient water supplies would be available to service providers relying on Central Valley Project (CVP)/State Water Project (SWP) exports			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note.[b]	Less than significant	NA
LSJR Alternative 2	Inflows would generally remain similar to baseline, which would result in an estimated average increase in exports of 18 TAF/y to the CVP and SWP export service areas. Therefore, insufficient water supplies to service providers relying on exports would not occur and would not require or result in the construction of new water supply facilities or wastewater treatment facilities or the expansion of existing facilities.	Less than significant	Less than significant
LSJR Alternative 3	Inflows would generally increase relative to baseline, which would result in an estimated average increase in exports of 76 TAF/y to the CVP and SWP export service areas. Therefore, insufficient water supplies to service providers relying on exports would not occur and would not require or result in the construction of new water supply facilities or wastewater treatment facilities or the expansion of existing facilities.	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternative 4	Inflows would generally increase relative to baseline, which would result in an estimated average increase in exports of 194 TAF/y to the CVP and SWP export service areas. Therefore, insufficient water supplies to service providers relying on exports would not occur and would not require or result in the construction of new water supply facilities or wastewater treatment facilities or the expansion of existing facilities.	Less than significant	Less than significant

CVP = Central Valley Project
DDW = Division of Drinking Water
dS/m = deciSiemens per meter (1 dS/m = 1000 µS/cm)
MCLs = maximum contaminant levels
NA = not applicable
NPDES = National Pollution Discharge Elimination System
SWP = State Water Project
TAF/y = thousand acre-feet per year
USBR = U.S. Bureau of Reclamation

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 13.4.2, *Methods and Approach*, of this chapter.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in implementation of flow objectives and salinity objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

[c] Salinity in the SJR at Vernalis and in the southern Delta is not relevant to groundwater and drinking water quality from domestic wells and, therefore, there would be no impact from the changes in salinity in these surface waters. This topic is not discussed further in Impact SP-2b.

13.2 Environmental Setting

This section characterizes the area of potential effects considered for the service providers impact analysis, which includes the plan area, the four groundwater subbasins as described in Chapter 9, *Groundwater Resources,* and those areas that receive water from the surface waters. This section provides information regarding the different service providers and the services provided by the water bodies in the area of potential effects. Numerous service providers rely on the water bodies in the area of potential effects for beneficial uses, such as irrigation and municipal and industrial supply. Services providers also use the water bodies as receiving waters in which to discharge treated wastewater effluent generated by residential, municipal, and industrial (i.e., domestic) uses in service districts in the area of potential effects.

13.2.1 Lower San Joaquin River and Tributaries

Service providers in the area of potential effects obtain their water supplies by either diverting surface water from the three eastside tributaries[5] or pumping groundwater from aquifers. These different sources of water and the service providers that rely on them are discussed below.

Surface Water and Service Providers

Five irrigation districts receive surface water from the Stanislaus, Tuolumne, and Merced Rivers and primarily supply agricultural uses with irrigation (Table 13-2). Descriptions and characteristics of the irrigation districts are provided in Chapter 2, *Water Resources* (Sections 2.3, 2.4, and 2.5). Some of the irrigation districts have contracts or agreements with other water users, such as water districts or conservation districts. The other water users provide water supply for both agricultural uses and municipal uses. These irrigation districts and the other water users are listed in Table 13-2.

Irrigation districts obtain the majority of their water supply from surface water diversions. The other water users primarily rely on groundwater or a combination of groundwater and surface water as their sources of water. Figure 13-1a identifies the location of the service providers that rely primarily or partially on surface water.

Groundwater and Service Providers

Groundwater is a vital resource in California. Typically, groundwater supplies approximately 30 percent of California's urban and agricultural uses. In dry years, groundwater use increases to approximately 40 percent statewide and 60 percent or more in some regions (DWR 2003). Drought conditions typically result in an increase of groundwater well activity and pumping to compensate for surface water supply shortages (DWR 2014). As a result of increased pumping in the recent drought, groundwater levels have decreased in many basins throughout the state since spring 2010. Basins with notable decreases in groundwater levels are in the Sacramento River, SJR, Tulare Lake, San Francisco Bay, Central Coast, and South Coast Hydrologic Regions (DWR 2014).

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[5] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

Table 13-2. Primary Surface Water Diverters and Other Water Users

Tributary River	Primary Surface Water Diverters	Other Water Users
Stanislaus[a]	OID, SSJID[b]	SEWD,[c] CSJWCD,[d] Tracy, Manteca, Lathrop, Ripon, Escalon
Tuolumne	MID, TID[e]	Modesto, CCSF[f]
Merced	Merced ID[g]	LeGrand Athlone Water District,[h] El Nido Irrigation District,[h] Stevinson Water District, Eastside Water District,[I] Lake Don Pedro CSD[j]

OID = Oakdale Irrigation District
SSJID = South San Joaquin Irrigation District
SEWD = Stockton East Water District
CSJWCD = Central San Joaquin Water Conservation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
CCSF = City and County of San Francisco
Merced ID = Merced Irrigation District
CSD = Community Services District

[a] U.S. Bureau of Reclamation (USBR) is contracted to provide surface water to SEWD and CSJWCD.

[b] SSJID and OID jointly hold contract rights with USBR to divert 600 thousand acre-feet (TAF). The primary use of the surface water diversions in the SSJID and OID service areas is agriculture; however, there are some water districts that are contracted with SSJID to provide water to municipal users.

[c] SEWD provides water to CalWater Services Company and Stockton Municipal Utilities District. The County of San Joaquin receives less than 2,000 acre-feet per year (AF/y) from SEWD.

[d] Although CSJWCD receives surface water from USBR, its primary water source is groundwater (San Joaquin County Department of Public Works 2004.)

[e] TID and MID customers primarily use water for agricultural irrigation, although some treated surface water is delivered to the City of Modesto.

[f] CCSF has agreements with MID and TID to provide carryover storage in New Don Pedro Reservoir. CCSF does not divert water directly from New Don Pedro Reservoir but owns the right to store up to 740 TAF of water in the reservoir. The 740-TAF water right is senior to TID and MID water rights. The current CCSF demand for water is approximately 290 TAF.

[g] Merced ID is the primary water diverter on the Merced River. Merced ID uses the surface water from the Merced River primarily for agricultural irrigation.

[h] LeGrand Athlone Water District and El Nido Irrigation District are within the sphere of influence of Merced ID, and El Nido Irrigation District was incorporated into Merced ID service area prior to 2008 (AMEC 2008).

[i] Eastside Water District receives limited amounts of surface water from Merced ID only during wet years (TGBA 2008).

[j] Lake Don Pedro Community Services District can withdraw up to approximately 5,000 AF/y from Lake McClure (Merced ID 2013).

As described in Chapter 9, *Groundwater Resources*, Section 9.2.2, *Subbasin Groundwater Use*, there are four main groundwater subbasins in the area of potential effects—the Eastern San Joaquin, Modesto, Turlock, and Extended Merced. Approximately 1,248,000 people live in areas overlying these four subbasins (U.S. Census Bureau 2010), and of this population, approximately 1,115,000 people, or 89 percent, receive some portion of their water supply from a public water supplier (California Environmental Health Tracking Program 2016). The remaining 11 percent, equivalent to approximately 133,000 people in the four main groundwater subbasins, rely solely on domestic[6] (i.e., private) wells for their water supply (Johnson and Belitz 2015). However, given the

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[6] For the purposes of this chapter, *municipal wells* refer to wells owned by public water suppliers, and domestic wells are private wells owned by individuals/households.

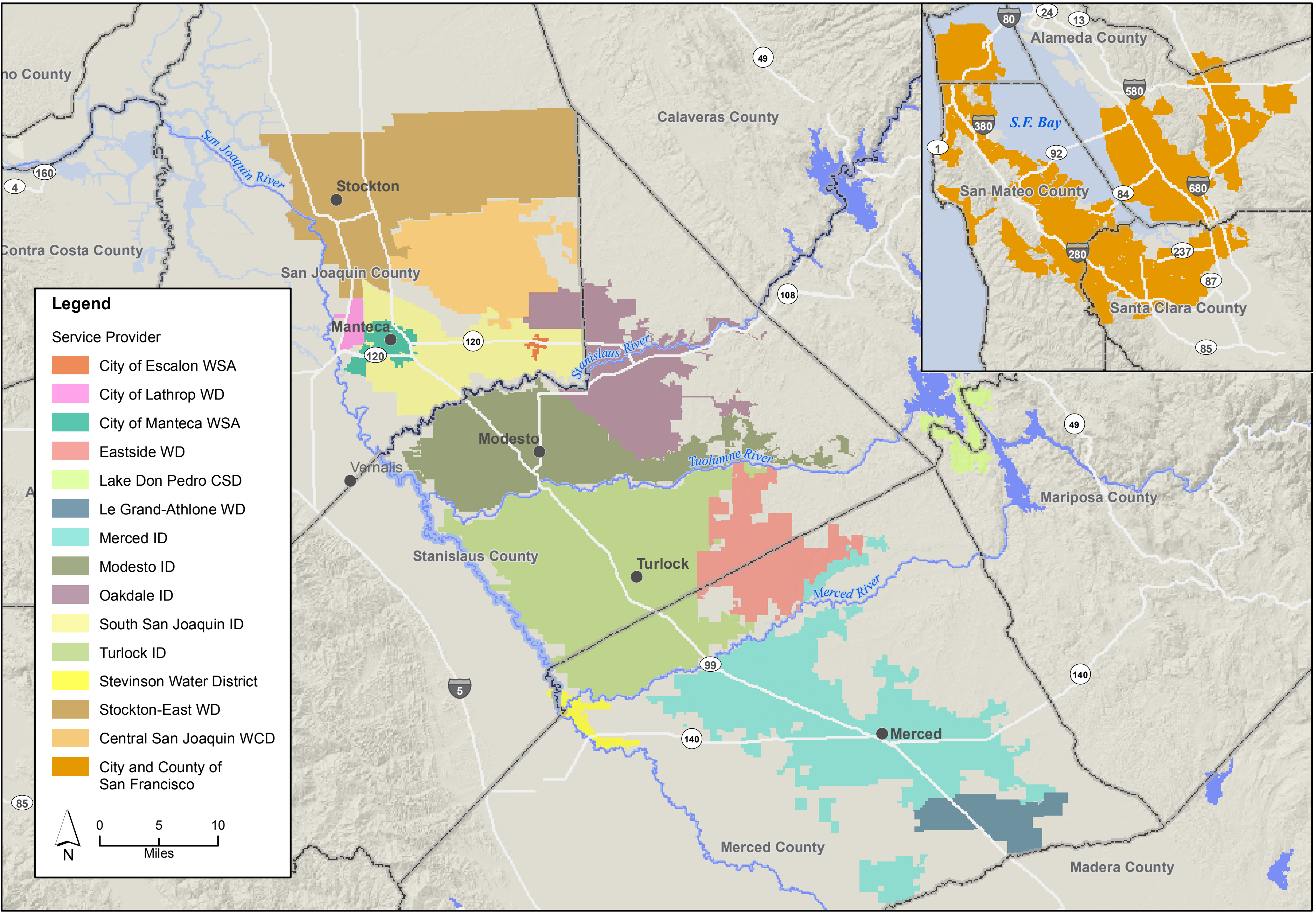

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Figure 13-1a
Vicinity Map of Service Providers Relying on Surface Water

incomplete records for private wells, it is difficult determine the actual number of people currently relying on private wells.

As shown in Table 13-3a (at the end of this chapter), 93 public water suppliers are identified within the four groundwater subbasins. Many of these water suppliers rely heavily or primarily on groundwater for municipal use. Table 13-3b identifies a subset of those public water suppliers listed in Table 13-3a. These are generally representative of the public water suppliers listed in Table 13-3a and well depth information could be obtained through the State Water Board's Division of Drinking Water (DDW) for this subset. Table 13-3b includes information regarding the size of the population served the water suppliers in 2014, the number of active wells owned by the suppliers in 2014, the percentage of groundwater supply reliance, the range of depths of the wells, and the range of depths to groundwater[7] at the wells. Figure 13-1b shows those service providers identified in Table 13-3b that rely solely on groundwater. Although information on private wells is limited, 66 domestic wells with well depth information were identified within the four groundwater subbasins based on information extract from the California Statewide Groundwater Elevation Monitoring (CASGEM) program (DWR 2015). The depth for these 66 wells ranges from 48 to 580 feet. Figure 13-2 shows the location of municipal and domestic wells relative to the groundwater subbasins and the irrigation districts in the area of potential effects.

Surface Water Quality

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, the water quality of the Stanislaus, Tuolumne, and Merced Rivers is primarily dictated by reservoir operations and agricultural return flow. Electrical conductivity[8] (EC) generally increases as water moves downstream in all three rivers because of the relatively high EC in agricultural drainage and groundwater discharge to the river. Chloride, bromide, sulfate, and boron are specific ions that contribute to overall salinity and are constituents of concern. However, of these constituents of concern in the area of potential effects, only boron is included on California's statewide list of impaired waterbodies (the 303[d] lists). Table 5-4 shows the constituents identified in the Section 303(d)[9] list for impaired waters in the plan area and other areas. The Tuolumne River, for example, is identified on the 303(d) list for constituents associated with agricultural uses, such as pesticides (chlorpyrifos, diazinon, DDT), and temperature (State Water Board 2011). Salinity can affect multiple beneficial uses, including the yield of crops that are sensitive to these constituents. Additionally, high EC values in source water may limit the ability to utilize recycled water. The presence of bromide in municipal water sources is also a concern because bromide is the precursor to the formation of harmful byproducts of the water disinfection process. However there are no 303(d) listings for bromide.

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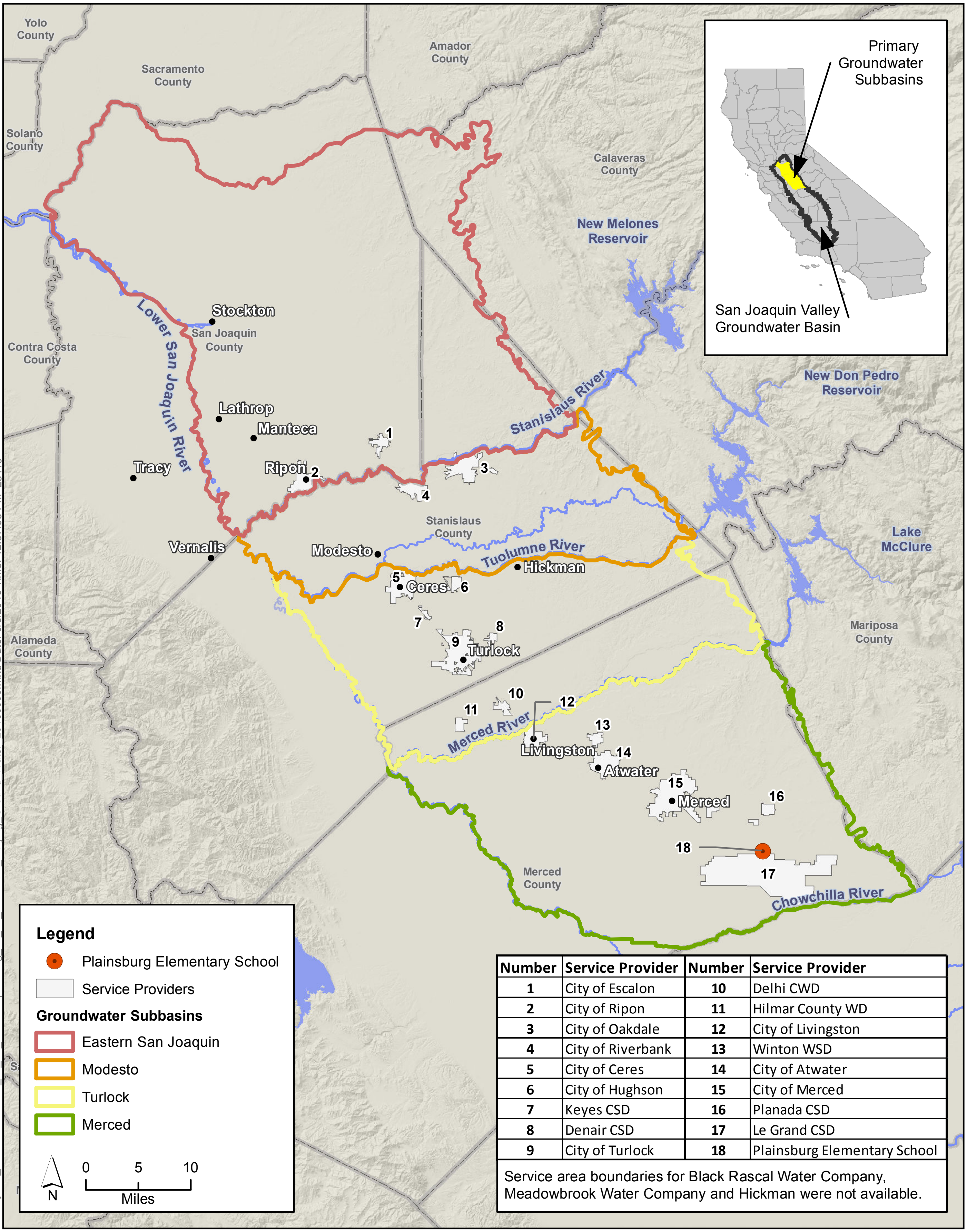
[7] The depth to groundwater refers to depth to the top of the aquifer.

[8] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

[9] Clean Water Act section 303(d) requires states, territories, and authorized tribes to develop a ranked list of water quality limited segments of rivers that do not meet water quality standards.

Table 13-3b. Groundwater Reliance and Summary of Well Information for Selected Public Water Suppliers in the Eastern San Joaquin, Modesto, Turlock, and Extended Merced Subbasins

Public Water System	Population Served	# of Active Wells in 2014	Groundwater Reliance in 2014 (%)	Range of Well Depths (feet)	Range of Depths to Groundwater[a] (feet)	Range of Difference[b,c] (feet)
Eastern San Joaquin Subbasin						
Cal Water, Stockton	185,346	26	26	400–857	34–83	340–515
Escalon	7,137	4	100	535–600	71–81	464–519
Lathrop	12,427	5	88	280–430	17–17	263–288
Lodi	63,395	28	73	315–600	58–137	213–481
Manteca	66,451	15	42	240–425	20–41	244–398
Ripon	14,915	7	100	158–462	39–46	118–423
SEWD	50[d]		0[e]	396–700	87–100	456–463
Stockton	169,963	21	23	232–590	35–72	194–526
Modesto Subbasin						
Modesto	212,000	68	61	110–500	49–79	52–436
Oakdale	19,250	8	100	380–604	82–116	264–501
Riverbank	22,201	10	100	260–830	81–87	179–525
Turlock Subbasin						
Ceres	42,666	15	100	240–450	63–74	190–367
Delhi CWD	5,640	4	100	355–608	90–97	265–516
Denair CSD	3,225	4	100	460–620	91–98	366–528
Hickman	565	2	100	284–332	116–117	167–216
Hilmar CWD	4,850	2	100	300–400	73–75	227–325
Hughson	6,082	3	100	260–445	85–85	265–360
Keyes CSD	4,575	4	100	335–425	65–70	269–355
Turlock	64,215	24	100	265–610	67–86	184–535



Number	Service Provider	Number	Service Provider
1	City of Escalon	10	Delhi CWD
2	City of Ripon	11	Hilmar County WD
3	City of Oakdale	12	City of Livingston
4	City of Riverbank	13	Winton WSD
5	City of Ceres	14	City of Atwater
6	City of Hughson	15	City of Merced
7	Keyes CSD	16	Planada CSD
8	Denair CSD	17	Le Grand CSD
9	City of Turlock	18	Plainsburg Elementary School

Service area boundaries for Black Rascal Water Company, Meadowbrook Water Company and Hickman were not available.

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Figure 13-1b
Vicinity Map of Selected Service Providers Relying Solely on Groundwater

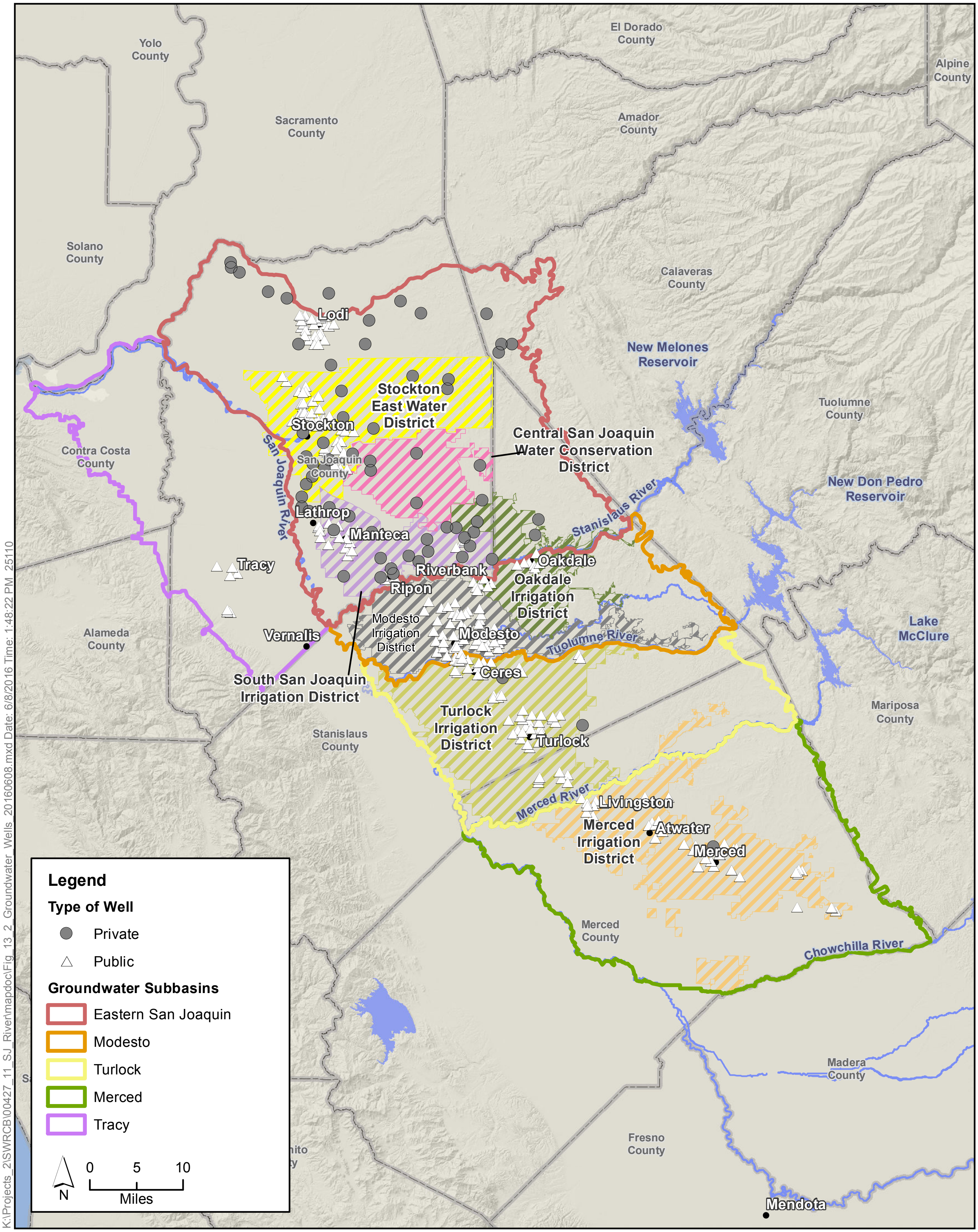

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Figure 13-2
Municipal and Domestic Groundwater Wells in the Eastern San Joaquin, Modesto, Turlock, Merced, and Tracy Groundwater Subbasins

Public Water System	Population Served	# of Active Wells in 2014	Groundwater Reliance in 2014 (%)	Range of Well Depths (feet)	Range of Depths to Groundwater[a] (feet)	Range of Difference[b,c] (feet)
Extended Merced Subbasin[f]						
Atwater	28,100	8	100	300–992	91–104	202–616
Black Rascal Water Company	393	2	100	NA	81–98	NA
Le Grand CSD	1,700	3	100	340–780	244–263	91–536
Livingston	13,940	8	100	284–518	73–90	204–430
Meadowbrook Water Company	6,309	3	100	371–528	88–95	276–440
Merced	80,095	22	100	152–800	87–107	55–713
Plainsburg Elementary School	150	1	100	600–600	142–142	458–458
Planada CSD	4,500	6	100	250–500	123–124	206–377
Winton WSD	8,500	3	100	395–965	121–121[g]	829–829[g]
Tracy Subbasin						
Tracy[h]	82,000	9	3	894–1216	186–202	788–826

Source: State Water Resources Control Board Division of Drinking Water 2016.

CSD = Community Services District
SEWD = Stockton East Water District
WD = Water District
WSD = Water and Sanitary District

[a] Range of depths to groundwater at the locations of the active wells owned by the public water supplier.

[b] Range of difference between well depths and depths to groundwater.

[c] Gray-shaded cells indicate that the difference between the depth of a well owned by the supplier and depth to groundwater at that well is less than 100 feet, which indicates that the well is potentially at a higher risk of running dry in the future.

[d] SEWD does not supply water to individual customers. SEWD sells water wholesale to different agencies. The 50 people that the water district serves are the employees working in its water treatment plant.

[e] SEWD had been relying solely on surface water between 2010 and 2014. In 2015, for the second consecutive year, SEWD did not receive their contracted water supply allocation from USBR due to lack of available CVP supplies resulting from severe drought conditions (Association of California Water Agencies 2015; SEWD 2016). Accordingly, SEWD reactivated the district's two inactive wells, built a new well and converted two old irrigation wells into drinking water wells (Sahota pers. comm.). The number of active wells in 2015 was five.

[f] As described in Chapter 9, *Groundwater Resources*, the Extended Merced Subbasin includes a portion of the Chowchilla Subbasin.

[g] Depth to groundwater data available only for one of three groundwater wells.

[h] Although the City of Tracy is not located in the four subbasins, it is within the area of potential effects because it receives water from SSJID and can be affected by the LSJR alternatives. Therefore, it is included in this table.

Groundwater Quality

As discussed in Chapter 9, *Groundwater Resources*, groundwater quality varies substantially throughout the San Joaquin Valley Groundwater Basin. In general, groundwater throughout the SJR region is suitable for most urban and agricultural uses. Groundwater in shallower aquifers generally contains higher concentrations of anthropogenic contaminants, such as nitrates and pesticides, than in deeper aquifers (DWR 2013). In addition to agricultural and industrial sources, trace elements (such as arsenic, manganese, vanadium and uranium) that are naturally occurring in rocks and soils can come in contact with the water and present water quality problems.

The Priority Basin Project of the Groundwater Ambient Monitoring and Assessment Program (GAMA) (Section 13.3.2, *State [Regulatory Background])* provides a comprehensive assessment of the state's groundwater quality. Two study units of the Priority Basin Project include the four groundwater subbasins that are subject to the LSJR alternatives: the Northern San Joaquin Valley (NSJ) study unit that includes the Eastern San Joaquin Subbasin and the Central Eastside study unit, which includes the Modesto, Turlock, and Extended Merced Subbasins[10].

In the NSJ study unit, one or more inorganic constituents (i.e., trace elements and nutrients, such as nitrate and nitrite) were detected at high concentrations in approximately 13 percent of the primary aquifers and at moderate concentrations in approximately 29 percent. The rest of the primary aquifers (58 percent) had low or no detections of inorganic constituents. Common sources of nutrients include fertilizers used in farming, seepage from septic systems, and human and animal waste. In the NSJ study unit, nutrients were present at high and moderate concentrations in approximately 2 and 9 percent of the primary aquifers, respectively (USGS and State Water Board 2010a). One or more organic constituents (i.e. volatile organic compounds [VOCs] and pesticides) were detected at high concentrations in approximately 3 percent of the primary aquifers and at moderate concentrations in approximately 7 percent. The remaining primary aquifers (90 percent) had low or no detections of organic constituents (USGS and State Water Board 2010a). VOCs are present in many household, commercial, industrial, and agricultural products, and are characterized by their tendency to volatilize into the air. Pesticides (herbicides, insecticides, and fumigants) are applied to crops, gardens, lawns, around buildings, and along roads to help control weeds, insects, fungi, and other pests. In the NSJ study unit, fumigants were detected at high concentrations in approximately 3 percent of the primary aquifers, and at moderate concentrations in approximately 3 percent. Herbicides and insecticides were detected at low concentrations in the primary aquifer (USGS and State Water Board 2010a).

In the Central Eastside study unit, one or more inorganic constituents were detected at high concentrations in 18 percent of the primary aquifer and at moderate concentrations in 44 percent. The rest of the primary aquifers (38 percent) had low or no detections of inorganic constituents (USGS and State Water Board 2010b). Nitrate was detected at high concentrations in approximately 2 percent of the primary aquifers and at moderate concentrations in approximately 15 percent of the primary aquifer. Concentrations of nitrate were low in the rest of the primary aquifers (83 percent) in the Central Eastside study unit. One or more organic constituents were detected at high concentrations in 1 percent of the primary aquifer and at moderate concentrations in

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[10] As described in Chapter 9, *Groundwater Resources*, the Merced Subbasin was extended for the analysis to include a part of the Chowchilla Subbasin.

14 percent. The rest of the primary aquifers (85 percent) had low or no detections of organic constituents (USGS and State Water Board 2010b). In the Central Eastside, the fumigant dibromochloropropane (DBCP)[11] was detected at high concentrations in approximately 1 percent of the primary aquifers, at moderate concentrations in approximately 8 percent of the primary aquifer, and at low or not detected in approximately 91 percent (USGS and State Water Board 2010b).

Salinity, measured as total dissolved solids (TDS) or EC, in the four subbasins is relatively low, while elevated salinity levels are common in San Joaquin Valley groundwater (DWR 2003a). Salinity is generally lower on the eastern side of the San Joaquin Valley Groundwater Basin than on the western side, and is generally higher in the shallow aquifer than the deep aquifer. The relatively low groundwater salinity on the eastern side can be attributed to the low salinity of Sierra Nevada runoff and application of surface water as a major irrigation source in the subbasins. However, there are some localized issues. For example, increased levels in groundwater salinity have been detected in the Stockton area due to a lateral saline front to the west (NSJCGBA 2004). In the Merced Groundwater Basin, high TDS concentrations are principally the result of the migration of a deep saline water body that originates in regionally deposited marine sedimentary rocks that underlie the San Joaquin Valley. Under natural pressure, the saline groundwater body is migrating upward. But pumping by deep wells in the western and southern parts of the Extended Merced Subbasin may be causing these saline brines to upwell and mix with fresh water aquifers more rapidly than under natural conditions (MAGPI 2008).

Quality of Groundwater as a Source of Drinking Water

It is estimated that 85 percent of California's community public water systems,[12] supplying more than 30 million residents, rely on groundwater for at least part of their drinking water supply (State Water Board 2013a). In addition, approximately 2 million Californians rely on groundwater from either private domestic wells or other groundwater-reliant systems not regulated by the state. Due to California's reliance on groundwater, and because many community water systems are entirely reliant on groundwater for their drinking water supply, contamination of this resource can have far-reaching consequences. Pursuant to the requirements of AB 2222 (Caballero, Chapter 670, Statutes of 2008), in 2013 State Water Board submitted a report to the legislature that identified: (1) communities in California that rely on contaminated groundwater as a primary source of drinking water, (2) the principal contaminants and other constituents of concern, and (3) potential solutions and funding sources to clean up or treat groundwater in community public water systems or provide alternative water supplies.

The report identifies that approximately one-fifth of California's groundwater-reliant community water systems, prior to any treatment, used a contaminated groundwater source between 2002 and 2010. During this period, of the 510 active wells (serving 148 community water systems) within the four subbasins, 134 active wells (serving 54 community water systems) had two or more MCL exceedances (State Water Board 2013a). It is important to note that these findings reflect raw, untreated groundwater quality and not necessarily the quality of the water that is eventually served to the public. Community water systems that rely on contaminated groundwater typically treat their well water before it is delivered and consumed. However, in some cases, when a community cannot

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[11] Use of DBCP as a soil fumigant was discontinued in California in 1977.

[12] A *community public water system* (community water system) serves at least 15 service connections used by yearlong residents or regularly serves at least 25 yearlong residents. Community water systems are regulated by the state.

afford treatment or alternative sources of water are not available, contaminated water is served to the public until a solution is implemented. Over 98 percent of Californians on a public water supply are served safe drinking water (State Water Board 2013a).

The report also identifies 31 principal contaminants[13] in the community water systems that rely on a contaminated groundwater source. The 10 most frequently detected principal contaminants, summarized in Table 13-4, were found in over 90 percent of the contaminated groundwater wells prior to treatment. Twenty-one of the 31 principal contaminants detected in community water system wells are anthropogenic in origin. Some principal contaminants were more frequently detected within certain regions of the state, while other principal contaminants were found statewide. In general, naturally occurring contaminants are detected statewide, while anthropogenic contaminants tend to be detected in particular regions of the state. For example, arsenic (naturally occurring) is detected in a wide distribution of community water system wells across the state. In contrast, nitrate (anthropogenic) is predominantly detected above the MCL in areas of the state with current or historical agricultural activity, including the southern San Joaquin Valley, the Salinas Valley, and in the Southern California Inland Empire (State Water Board 2013a).

Table 13-4. Ten Most Frequently Detected Principal Contaminants Identified in State Water Board 2013a

Principal Contaminant	Number of Wells[a]	Type of Contaminant[b]
Arsenic	587	Naturally occurring
Nitrate	451	Anthropogenic nutrient
Gross alpha activity	333	Naturally occurring
Perchlorate	179	Industrial/Military use
Tetrachloroethylene (PCE)	168	Solvent
Trichloroethylene (TCE)	159	Solvent
Uranium	157	Naturally occurring
1,2-dibromo-3-chlropropane (DBCP)	118	Legacy pesticide
Fluoride	79	Naturally occurring
Carbon tetrachloride	52	Solvent

Source: State Water Board 2013a.

[a] This is the number of wells in which the contaminant was detected,

[b] Also can be naturally occurring, but typically at levels below the MCL

As shown in Table 13-4, nitrate is the second most frequently detected principal contaminant in groundwater, and at concentrations above its drinking water standard MCL of 45 milligrams per liter (mg/L), it is considered anthropogenic, making it the most frequently detected anthropogenic chemical above an MCL in drinking water sources. Agricultural fertilizers and animal wastes applied to cropland are major sources of nitrate in groundwater. Hence, nitrate is often used as an indicator of agricultural impact on groundwater quality. Nitrate is one of California's most prevalent groundwater contaminants, and can pose significant health risks at concentrations above the MCL (State Water Board 2013b). Harter et al. (2012) found that travel times of nitrate from source to wells range from a few years to decades in domestic wells, and from years to many decades and

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[13] A *principal contaminant* is a chemical detected in a groundwater source sample above a primary MCL on two or more occasions during the most recent CDPH compliance cycle (2002–2010).

even centuries in deeper production wells. This means that elevated nitrate concentration in groundwater will remain high for a long time even if nitrate application is reduced today, and that reduction efforts are essential for any long-term improvement of drinking water sources.

Groundwater Quality and Over-Pumping

As discussed above, over pumping of groundwater has been depleting the groundwater resources in the San Joaquin Valley. One impact of over-drafting groundwater is degradation of groundwater quality. Prior to any development, natural recharge to, and discharge from, the groundwater system was in a dynamic steady state, and the groundwater table was stable. When a well is built and water is pumped from the aquifer, a cone of depression will be created at the well and the water table will be lowered. When pumping is stopped, subsequent recharge will allow the water level to rise, and the groundwater table is restored. If pumping continues, the groundwater level will decline and continue to do so until it stabilizes at a new, lower level. If pumping is persistently greater than recharge, the aquifer will eventually be dewatered. Lowering the groundwater table will alter the direction and rate of the groundwater flow and create a hydraulic gradient between the well and surrounding saturated zone. This can affect groundwater quality in the following ways.

1. Migration of surface contaminants to the well. Contaminants introduced at the land surface that infiltrate into the water table can flow towards the well. Contaminated shallow groundwater will also move downward within the aquifer and, eventually, into the zone of drinking water wells. Sources of chemicals introduced to ground water in this way include fertilizers, manure, and pesticides applied to agricultural lands; landfills; industrial-discharge lagoons; leaking gasoline storage tanks; cesspools and septic tanks; and domestically used chemicals. The slow movement of water from the surface through the unsaturated zone to deep aquifers means that it may be many years after a persistent chemical has entered the ground before it affects the quality of groundwater supplies (Morris et al. 2003; Harter et al. 2012). For example, while the San Joaquin Valley is not characterized by high concentrations of nitrates at the depth zone used for public supply, application of fertilizers and animal manure to agricultural land has caused downward movement of nitrates into the soil. As groundwater pumping continues and as irrigation water containing elevated concentrations of nitrate moves toward and through deeper parts of the aquifer, high concentrations of nitrates in the public water supply could be a concern in the future (Belitz et al. 2015).

2. Saline water intrusion. Under natural conditions the boundary between the freshwater and saltwater tends to be relatively stable, but pumping can cause saltwater to migrate inland and upward, resulting in saltwater contamination of the aquifer. Saltwater intrusion is an important consideration for aquifers adjacent to the coast or other saline bodies. The mobility of such saline waters depends upon the hydraulic gradients, permeability of the aquifer and the presence or absence of hydraulic barriers (Morris et al. 2003). Serious saline intrusion is confined to relatively few hydrogeological settings, but these are not necessarily coastal as paleo-saline waters may occur in inland aquifers at depth (Morris et al. 2003).

3. Mobilization of naturally-occurring trace elements such as uranium, arsenic, and radium. Pumping-induced mobilization of those elements has been studied around the world. Although the occurrence of trace elements (e.g., arsenic and uranium) is not anthropogenic, these elements can leach into groundwater and be mobilized by human activities (Smedley and Kinniburgh 2002; Barringer and Reilly 2013). For example, the downward infiltration of irrigation water with elevated bicarbonates caused movement of uranium in an area of the eastern San Joaquin Valley (Belitz et al. 2015).

The processes discussed above can be influenced by many factors, including location and depth of the well, the amount and frequency of groundwater pumping, number and proximity of nearby wells, aquifer characteristics (e.g., consolidated clays with low permeability or unconsolidated sands with high permeability), distance between the well(s) and the contaminant(s), contaminant characteristics (e.g., highly mobile in water or adhering primarily to soil), and land use near the well.

In general, water delivered to the end users from municipal drinking water wells does not exceed federal and state MCLs. This is because municipal wells are generally deep, and water quality tends to be better in deeper aquifers. Furthermore, water quality is managed such that if violation of drinking water standards is found at a public well, the well can be brought offline and corrective actions will be taken to ensure the water meet the MCL requirement again before it is delivered the consumers. For example, DBCP was detected over the MCL at two of the City of Atwater's wells. Granular Activated Carbon filtering systems were installed on these water sources to remove the contaminant prior to introduction of water into the city's water system (City of Atwater 2015). The City of Livingston, located in the Extended Merced Subbasin, recently improved filtration in order to reduce arsenic concentrations that were above the state MCL (Giwargis 2014).

In addition, water quality in community water systems is frequently monitored by the DDW and the service providers pursuant to various regulatory requirements stated in Section 13.3, *Regulatory Background*. As described in Section 13.3.1, *Federal [Regulatory Background]*, community water systems must provide annual drinking water quality reports, known as consumer confidence reports (CCRs), to their customers. Table 13-5 provides information from CCRs of selected municipalities in the groundwater subbasins during representative drought and non-drought years. These municipalities were selected because they are the major groundwater producers and together represent a wide range of total number of wells and locations in all four groundwater subbasins.

Private drinking water wells may have more significant water quality issues than municipal wells because they are often shallower than municipal wells and, therefore, are more susceptible to surface contaminants. However, the state does not regulate the water quality of private drinking water wells and does not require private drinking water well owners to test for water quality. As such, there is no comprehensive dataset on private drinking water quality, and there is a lack of water quality data for private drinking water wells within the area of potential effects.

Table 13-5. Primary Detected Contaminants in Exceedance of Maximum Contamination Level in Drinking Water for Selected Water Suppliers during Representative Non-Drought and Drought Years

		Non-Drought Year (2011)			Drought Year (2014)		
Public Water Supplier	Source of Water	Violation? (Y/N)	Primary Detected Contaminant	Corrective Action	Violation? (Y/N)	Primary Detected Contaminant	Corrective Action
Atwater	groundwater	N	NA	NA	N	NA	NA
Manteca	groundwater and surface water	Y	Arsenic in exceedance of the MCL (10 ppb) was detected in groundwater.[a]	Filters were installed to remove arsenic from wells where MCL was exceeded. Maximized water production from sources with low arsenic levels.	N	NA	NA
Merced	groundwater	N	NA		N	NA	NA
Modesto	groundwater and surface water	N	NA	NA	N	NA	NA
Riverbank	groundwater	Y	Total coliform bacteria	Drinking water system was disinfected, flushed, and contamination was resolved.	N	NA	NA
Stockton	groundwater and surface water	N	NA		N	NA	NA
Turlock	groundwater	Y	Arsenic[a]	Two wells with arsenic in exceedance of the MCL (10 ppb) were immediately removed from service.	N	NA	NA
SEWD	surface water	N	NA	NA	N	NA	NA

Source: City of Manteca 2012a and 2014; City of Merced 2011 and 2015; City of Modesto 2011 and 2014; City of Stockton 2011a and 2014; City of Turlock 2011 and 2014; City of Atwater 2011 and 2015; City of Riverbank 2011 and 2014; SEWD 2014.

SEWD = Stockton East Water District
MCL = maximum contaminant level
ppb = parts per billion
ppm = parts per million
NA = not applicable

[a] The U.S. Environmental Protection Agency reduced the MCL for arsenic from 50 ppb down to 10 ppb in 2001. This new MCL (10 ppb) became enforceable in January 2006. Water systems that are in violation of this MCL must include a health effects statement in their consumer confidence reports covering calendar year 2006 and beyond.

13.2.2 Extended Plan Area

There are 55 public water suppliers identified in the extended plan area (State Water Board 2016a; State Water Board 2016b; CEHTP 2016). Of these 55, 44 suppliers rely completely on groundwater and three have pre-1914 or riparian rights (State Water Board 2016a) and, as such, are not expected to be affected by water supply bypasses in the extended plan area. Twelve (identified in Table 13-6) of these 55 service providers have post-1914 water rights and rely on surface water diversions (State Water Board 2016a). The total annual water production by the 55 service providers in 2014 was 9.85 TAF, of which 7.61 TAF was produced by the 12 service providers listed in Table 13-6.

Table 13-6. Annual Water Use of Service Providers in the Extended Plan Area with Post-1914 Water Rights

Service Providers	Water Production in 2014 (TAF)
Calaveras County Water District (Copper Cove)	1.25
Calaveras County Water District (Ebbetts Pass)	1.50
City of Angels Camp	0.99
Del Oro Water Company (Strawberry District)	0.04
Groveland CSD	0.38
Lake Alpine Water Company	0.04
Tuolumne Utilities District (Columbia Water System)	0.48
Tuolumne Utilities District (Sonora/Jamestown Water System)	1.84
Tuolumne Utilities District (Cedar Ridge Water System)	0.12
Twain Harte CSD	0.22
Union Public Utility District	0.70
Yosemite National Park (Wawona)	0.05
Total	**7.61**

Source: State Water Resources Control Board, Division of Drinking Water 2016.
TAF = thousand acre-feet
CSD = Community Services District

13.2.3 Southern Delta

Many factors influence southern Delta water quality, such as the amount and salinity concentration of SJR flow entering the southern Delta at Vernalis; daily tidal action; CVP and SWP pumping operations; agricultural return flows; municipal wastewater discharges; and other influences. Chapter 2, *Water Resources* (Section 2.7, *Southern Delta*) and Chapter 5, *Surface Hydrology and Water Quality* (Section 5.2.8, *Southern Delta*) also provide additional information regarding southern Delta hydrodynamics. The sections below summarize the information found in these two chapters and provide additional information that describes the southern Delta's water quality (salinity) objectives, the factors that affect its existing salinity, the wastewater treatment plants (WWTPs) that discharge into the southern Delta and their effluent limitations, and the water suppliers that use the southern Delta as a source for drinking water.

Water Quality Objectives

The 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan) identifies specific water quality objectives for EC, a primary indicator of salinity, for the southern Delta, for the protection of agricultural beneficial uses. The 2006 Bay-Delta Plan and the objectives are fully described in Section 13.3.2, *State [Regulatory Background]*, of this chapter. The numeric objectives for the southern Delta are as follows and are monitored at four compliance stations (SJR at Vernalis [C-10], SJR at Brandt Bridge [C-6], Old River near Middle River [C-8], and Old River at Tracy Boulevard Bridge [P-12]).

- 0.7 dS/m during the summer irrigation season (April–August).
- 1.0 dS/m during the winter season (September–March).

Water quality standards for drinking water are discussed below.

Existing Salinity

Salinity levels in the southern Delta are affected by complex hydrodynamics, including: inflow from the SJR at Vernalis; land use activities (e.g., agriculture) and discharges in the southern Delta; the seasons, tidal action, the placement of temporary barriers to reduce the effects of tidal action; the position of the Delta cross channel gates; and CVP and SWP exports.

The LSJR delivers water of relatively poor quality to the Delta, with agricultural drainage to the river being a major source of salts. Flow at Vernalis is typical of the inflow that the SJR contributes to the southern Delta. There is a strong relationship between the salinity concentrations at Vernalis and the salinity concentrations at Brandt Bridge and Old River at Middle River under most conditions (Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta)*. The salinity concentrations in the southern Delta typically increase slightly from agricultural drainage and treated effluent discharges to the southern Delta downstream of Vernalis.

Salinity also varies greatly in the southern Delta with the seasons and the tides. Winter salinity is mostly influenced by runoff from agricultural fields, while fall salinities tend to be influenced by seawater intrusion. The tides also influence the salinity by enhancing mixing. Generally, when temporary barriers are installed, tidal exchange is reduced. The temporary rock barriers (Old River Barrier near Delta-Mendota Canal, Middle River Barrier, and Grant Line Canal Barrier) are generally installed during the spring and removed in the fall (late September–November). Salinity in the southern Delta during lower flow periods can increase as a result of other sources (e.g., discharge of agricultural drainage, discharge of WWTPs).

An additional barrier, the Head of Old River Barrier (HORB), is occasionally installed during the spring to block passage of migrating fish into Old River. When installed, it reduces the normal diversion of SJR flow into Old River and the majority of the LSJR flows north to the Stockton Deep Water Ship Channel. However, some of the LSJR flow is drawn through Turner Cut and Middle River and Victoria Canal toward the CVP and SWP pumping facilities. The volume of water exported at the CVP and SWP can modify salinity concentrations in the southern Delta by affecting the partitioning of net flow through the various Delta channels.

Despite the variable hydrodynamics described above, the measured EC values throughout the southern Delta indicate the monthly patterns of EC are generally below the existing salinity objectives (i.e., 0.7 dS/m during the summer irrigation season [April–August] and 1.0 dS/m during the winter irrigation season [September–March]). The monthly increases in downstream salinity are greatest when the LSJR flow is low because dilution of agricultural drainage and municipal discharge will be less when the LSJR flow is low. Appendix F.2 describes the historical EC values at Vernalis and the interior compliance stations. There have been periodic exceedances in recent dry years at one or more of these southern Delta monitoring stations, but high salinity is not the general pattern. Based on the historical data, the salinity in the southern Delta is generally increased by a maximum of 0.2 dS/m above the Vernalis salinity, although the increment is sometimes higher in Old River at Tracy Boulevard. The existing salinity in the southern Delta generally ranges between 0.2 dS/m and 1.2 dS/m across all months of the year. Compliance with salinity objectives at Vernalis has been consistently achieved over the past 15 years. On average, salinity increases by 0.050 dS/m between Vernalis and Brandt Bridge (Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.2). The historical salinity increase between Vernalis and Old River at Tracy Boulevard is greater, averaging approximately 0.150 dS/m, with several monthly increases of more than 0.200 dS/m. Thus, when salinity at Vernalis is at the Vernalis EC objective, the salinity in the southern Delta is generally maintained between 0.7 dS/m and 1.2 dS/m (based on the historical monthly EC record).

Wastewater Dischargers

Existing WWTPs discharge treated wastewater effluent into the southern Delta and are considered point sources under the Clean Water Act (CWA). (33 U.S.C., § 1362, subd. (14).) Because treated wastewater effluent is a source of salt, these dischargers influence southern Delta salinity. There are six WWTPs that discharge into or are in the vicinity of the southern Delta, all of which are required to comply with effluent limitations established by National Pollution Discharge Elimination System (NPDES) permits (see Section 13.3.1, *Federal [Regulatory Background]*). These WWTPs, their receiving water bodies, and their total permitted discharge rates are listed in Table 13-7. Figure 2-12 shows the locations of WWTPs, compliance station locations, and nearby drinking water supply intakes.

Table 13-7. Wastewater Treatment Plants with Discharges in the Southern Delta

WWTP Facility	Current NPDES Permit Order Number	Receiving Water	Permitted Discharge (mgd)
Tracy [a]	R5-2012-0115	Old River (upstream of Doughty Cut)	16
Deuel	R5-2014-0014-01	Paradise Cut and Old River	0.62
Manteca [b]	R5-2015-0026	San Joaquin River	17.5
Stockton	R5-2014-0070	San Joaquin River	55
Mountain House CSD [c]	R5-2013-0004	Old River	5.4
Discovery Bay CSD	R5-2014-0073	Old River	2.1

WWTP = wastewater treatment plant
mgd = million gallons per day
NPDES = National Pollutant Discharge Elimination System
CSD = Community Services District

[a] In accordance with *City of Tracy v. State Water Board,* the existing southern Delta salinity objectives are not applied to Tracy and other municipal dischargers pending reconsideration of the southern Delta salinity objectives under Water Code §13241 and adoption of a proper program of implementation under Water Code §13242. Current capacity of Tracy's WWTP is 10.8 mgd, but there are plans to expand to 16.0 mgd within the permit term.

[b] Amended by Order R5-2015-0044. The Manteca Wastewater Quality Control Facility is currently designed for a discharge of 9.87 mgd but plans to expand to 17.5 mgd.

[c] The Mountain House CSD is currently designed for a discharge rate of 3 mgd but plans to expand to 5.4 mgd within the permit term.

Overall, the WWTPs have only a small effect on southern Delta salinity (Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*). For example, Tracy's discharge has limited effects on the overall salinity in the southern Delta compared to other sources of salinity in the area (e.g., water from agricultural activities and groundwater accretions). The permitted maximum salinity loads from the Tracy, Deuel, and Mountain House Community Services District (CSD) entering at the Head of Old River indicates that the salt load from point sources in this part of the southern Delta is a small percentage of the salt load entering from upstream. The salinity from wastewater discharges is generally exported at the CVP Jones Pumping Plant and SWP Banks Pumping Plant.

These WWTPs have effluent limitations that are established through the NPDES permits and waste discharge requirements (WDRs) issued by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) (see Section 13.3.1, *Federal [Regulatory Background]*). These effluent limitations are set by discharge permits for a wide variety of constituents including salt, and regulate the quality of the treated effluent discharged from the WWTPs. Except for Deuel,[14] the EC effluent limits for the WWTPs are currently based on facility performance to ensure salinity levels do not increase. Except for Deuel, at all of these WWTPs the existing NPDES requirements allow salinity of the discharge to be greater than the existing salinity objectives for the southern Delta as a result of litigation in *City of Tracy v. State Water Board*, under which the State Water Board was enjoined from applying the Delta salinity water quality objectives to the City of Tracy and other municipal discharger pending reconsideration and implementation of the objectives in accordance with Water Code Sections 13241 and 13242. Generally, the WWTPs of the southern Delta are in compliance with the current EC effluent limitations. The discharge permits also require the preparation of a salinity management plan (Harder pers. comm.; Martin pers. comm.). Table 13-8 identifies annual average EC of each WWTP for 2011–2014. Table 13-9 identifies the average April–August EC and the remainder of the year. Table 13-10 is a summary of southern Delta WWTPs' compliance with NPDES salinity requirements and salinity management plans.

Some service providers (i.e., WWTPs) are currently planning to modify existing facilities to reduce salinity loads. Of the six WWTPs discussed herein, two have made efforts or are working toward reducing salinity concentrations in their source water supplies, four are implementing pretreatment programs to reduce water softener use among water users, and three are either proposing to construct or are already operating a reverse osmosis (RO) treatment system. Table 13-11 summarizes the salinity reduction efforts of the various WWTPs.

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[14] The EC effluent limits for Deuel are based on the 2006 Bay-Delta Plan water quality objectives for salinity, not on facility performance.

Table 13-8. Southern Delta Wastewater Treatment Plant Salinity (EC) Effluent Data (dS/m [µmhos/cm])[a]

Facility	2011 Annual Average EC Effluent	2012 Annual Average EC Effluent	2013 Annual Average EC Effluent	2014 Annual Average EC Effluent	2015 Annual Average EC Effluent
Tracy[b]	1.2 [1,1171]	1.2 [1,229]	1.2 [1,250]	1.3 [1,342]	1.2 [1,246]
Deuel	2.4 [2,415][c]	1.4 [1,410][d]	1.3 [1,280]	1.3 [1,275]	2.2 [2,254]
Manteca	0.8 [781]	0.8 [778]	0.7 [750]	0.7 [745][b]	0.8 [800]
Stockton[b]	1.0 [1,032]	1.0 [958]	1.0 [973]	1.0 [982]	1.1 [1,127]
Mountain House CSD	0.7 [693]	0.9 [908]	1.0 [990]	1.0 [991]	1.0 [1,029]
Discovery Bay CSD[e]	2.2 [2,167]	2.2 [2,173]	2.0 [2,006][f]	2.0 [2,054]	2.0 [2,058]

Sources: CIWQS 2011, 2012, 2013, 2014, 2015.

EC = electrical conductivity (salinity)

µmhos/cm = micromhos per centimeter

dS/m = deciSiemens per meter (1 dS/m = 1000 µS/cm). Numbers presented in dS/m were rounded.

CIWQS = California Integrated Water Quality System Project

CSD = Community Services District

[a] Based on monthly samples (January–December) unless otherwise noted.

[b] Based on weekly samples (January–December).

[c] No data on CIWQS, so the comparison to potential effluent limitations is based on recent ACLC R5-2011-0575, which reported an average monthly EC value of 2,260 µmhos/cm on January 31, 2011 and 2,570 µmhos/cm on February 28, 2011.

[d] Based on monthly samples (February–December).

[e] Based on biweekly samples (January–December)

[f] Based on biweekly samples (January–June and August – December)

Table 13-9. Southern Delta Wastewater Treatment Plant Salinity (EC) Effluent Data April–August and Remainder of the Year (dS/m [µmhos/cm])[a]

	2011 April–August	2011 Jan–Mar, Sept–Dec	2012 April–August	2012 Jan– Mar, Sept–Dec	2013 April–August	2013 Jan– Mar, Sept–Dec	2014 April–August	2014 Jan– Mar, Sept–Dec	2015 April–August	2015 Jan– Mar, Sept–Dec
Facility	Average EC Effluent	Average EC Effluent	Average EC Effluent	Average EC Effluent	Average EC Effluent	Average EC Effluent	Average EC Effluent	Average EC Effluent	Average EC Effluent	Average EC Effluent
Tracy [b]	1.2 [1,201]	1.2 [1,171]	1.2 [1,228]	1.2 [1,229]	1.3 [1,269]	1.2 [1,236]	1.3 [1,295]	1.4 [1,374]	1.3 [1,307]	1.2 [1,206]
Deuel	— [c]	2.6 [2,570][c]	2.2 [2,193]	0.8 [759][d]	0.8 [823]	1.6 [1,606]	0.7 [712]	1.7 [1,676]	1.7 [1,674]	2.7 [2,668]
Manteca	0.8 [793]	0.8 [774]	0.8 [786]	0.8 [774]	0.7 [739]	0.8 [759]	0.8 [770][e]	0.7 [728][b]	0.8 [842]	0.7 [768]
Stockton [b]	1.0 [1,054]	1.0 [1,015]	1.0 [996]	0.9 [930]	1.0 [965]	1.0 [978]	1.0 [1,005]	1.0 [965]	1.2 [1,173]	1.1 [1,093]
Mountain House CSD	0.7 [660]	0.7 [722]	0.9 [908]	0.8 [817]	1.0 [966]	1.0 [1011]	1.0 [1,009]	1.0 [979]	1.0 [1,038]	1.0 [1,022]
Discovery Bay CSD [e]	2.2 [2,180]	2.2 [2,125]	2.2 [2,153]	2.2 [2,187]	2.2 [2,186] [f]	1.9 [1,894]	2.1 [2,104]	2.0 [2,009]	2 [2,052]	2.1 [2,061]

Sources: CIWQS 2011, 2012, 2013, 2014, 2015.

CIWQS = California Integrated Water Quality System Project
CSD = Community Services District
dS/m = deciSiemens per meter (1 dS/m = 1000 µS/cm). Conversion is 1 dS/m = 1000 µmhos/cm. Numbers presented in dS/m were rounded.
EC = electrical conductivity (salinity)
µmhos/cm = micromhos per centimeter

[a] Based on monthly samples unless otherwise noted.

[b] Based on weekly samples.

[c] No data in CIWQS, so the comparison to potential effluent limitations is based on recent ACLC R5-2011-0575, which reported an average monthly EC value of 2.600 dS/m (2,570 µmhos/cm) on February 28, 2011.

[d] No data in CIWQS for January.

[e] Based on biweekly samples.

[f] No data in CIWQS for July 2013. Therefore, this value represents the EC effluent average for April–June, and August.

Table 13-10. Current Southern Delta Wastewater Treatment Plant Compliance Status with National Pollutant Discharge Elimination System Permit Special Provisions for Salinity Requirements

Facility	Requirements	Deadline	Compliance Status
Tracy	Salinity Reduction Plan, which includes a PPP	March 1, annually	Submitted Salinity PPP Report on March 1, 2015
Deuel	PPP for Salinity	December 1, annually	Submitted PPP for salinity on January 13, 2015
Manteca	PPP for Electrical Conductivity	December 1, annually	Submitted PPP on October 20, 2014
Stockton	PPP for Salinity, progress reports	June 1, annually, beginning 2015	Submitted PPP for salinity on May 26, 2015
Mountain House CSD	Salinity Reduction Plan, which includes a PPP	June 1, annually	Submitted Salinity Reduction Progress Report on May 19, 2015
Discovery Bay CSD	PPP for Salinity	January 30, annually	Submitted PPP for salinity on January 12, 2015

Note: Table updated in 2015.

PPP = Pollution Prevention Plan
CSD = Community Services District
WW = Wastewater

Table 13-11. Salinity Reduction Efforts of Southern Delta Wastewater Treatment Plant Dischargers

	Salinity Reduction Efforts		
WWTP Facility	Source Water	Pretreatment Program	WWTP Desalination
Tracy	Addition of freshwater from New Melones Reservoir to groundwater supplies Construction of an Aquifer Storage and Recovery (ASR) well pilot project; permanent ASR is anticipated based on pilot project	Reduction in water softeners	Currently proposing a desalination plant (RO treatment); released public initial study/mitigated negative declaration (IS/MND) for the Tracy Desalination and Green Energy Project in April 2012
Deuel	No plans for changes to groundwater supplies	No pretreatment program, and none required	Constructed an RO groundwater treatment system with brine concentrator in 2010
Manteca	No plans for changes to 50 percent surface water from SSJID and 50 percent groundwater	Reduction in water softeners	No plans for desalination at WWTP
Stockton	Implementing Delta Water Supply Project for conjunctive use planned for 2012	Reduction in water softeners and TDS from industries	No plans for desalination at WWTP, but proposes to replace alum with polymer, submit inflow and infiltration study to identify salinity sources and loads, and implement Capital Improvement Energy Plan to meet salinity limitations
Mountain House CSD	No plans for changes to surface water from Clifton Court Forebay	Reduction in water softeners	No plans for desalination at WWTP
Discovery Bay CSD	—	—	Evaluated feasibility of constructing RO treatment system in 2010 Wastewater Master Plan

Note: The past and current violations at Deuel are potentially attributed to a malfunction of the RO and brine conversion systems used by the facility to reduce the salinity of the groundwater supply.

WWTP = wastewater treatment plant
RO = reverse osmosis
SSJID = South San Joaquin Irrigation District
TDS = total dissolved solids
CSD = community service district

Each of the current dischargers to the southern Delta is described below, including characteristics of the WWTP, salinity requirements, recorded violations in 2011, and currently implemented salinity control measures.

City of Tracy

Tracy discharges tertiary treated wastewater into Old River, which is a side branch of the SJR and contributes water to Clifton Court Forebay, a drinking water source for Southern California. The current NPDES discharge permit (Order No. R5-2012-0115) covers the main domestic wastewater treatment facility and an industrial pretreatment facility, including pretreated wastewater from the Leprino Foods Company (Leprino), a local cheese manufacturer (Central Valley Water Board 2012). All wastewater is discharged from Discharge Point 001 to Old River, located 3.5 miles north of the WWTP upstream of Paradise Cut (Figure 2-12). The nearest compliance monitoring station is station P-12 (Old River at Tracy Boulevard Bridge), approximately 4 miles west (downstream) of the discharge point (Central Valley Water Board 2007a). The nearest drinking water intakes are the CVP and SWP, which are approximately 10 miles downstream of the discharge (Central Valley Water Board 2007a).

Tracy's treated wastewater effluent is high in salt partly due to the municipal water supply and from significant salt loading from Leprino. Although Leprino provides preliminary treatment of its wastewater to reduce the high organic loading typical of food processing waste, no specific pretreatment is provided to reduce the high salt loading.

Tracy does not currently have EC effluent limitations; however, it still monitors for EC, as required by its NPDES permit, and has initiated salinity reduction efforts. The average EC of Tracy's wastewater effluent has not changed substantially over the past few years, although it did experience a slight increase in 2014 (Tables 13-7 and 13-8). Tracy submitted a salinity reduction plan in 2008 that describes the approach to identify, evaluate, and implement measures to reduce salinity in the effluent discharge and meet the interim salinity goal. Tracy also submitted a salinity best practicable treatment or control evaluation and salinity pollution prevention plan (PPP) in compliance with NPDES permit requirements.

Salinity Reduction Efforts

Source Water Supplies

Historically, the largest source of salinity in Tracy's wastewater effluent was the groundwater used as a potable water supply for the community. Tracy has obtained surface water potable supplies to replace the use of groundwater. Groundwater usage was reduced from 7,176 acre-feet (AF) in 2004 to 1,327 AF in 2009. As a result, there has been a reduction of approximately 5,000 tons of salt per year (Bayley pers. comm.). Additionally, Tracy is contracted with SSJID to receive water from New Melones Reservoir, and this additional water contributes to the reduction of salinity in the effluent (Tracy Press 2011). Additionally, Tracy completed construction of an Aquifer Storage and Recovery (ASR) well pilot project in 2012. The Central Valley Water Board must approve pilot tests on injection of drinking water into the groundwater basin. The permanent ASR project is planned for 2013 upon completion of environmental review. Tracy successfully commenced a pilot project to store surplus surface water supplies in the Semitropic Water Storage District in Kern County (Marshall pers. comm. 2012a).

Salinity Pretreatment Program

Replacing some groundwater with surface water for source water supplies has reduced the need for salt-based, self-regenerating water softeners, which contribute additional salinity to wastewater. These water softeners contribute to salinity because as they reduce hardness ions (e.g., calcium and magnesium), they produce a byproduct of a concentrated solution of the hardness ions and chloride that is discharged to the WWTP. This discharge increases the salinity of the wastewater entering the WWTP and the overall salinity of the treated effluent discharged from the WWTP. According to Tracy, there has been an observable significant decrease in the salinity of the wastewater effluent due to a reduction in the use of water softeners (City of Tracy 2008).

Desalination at the WWTP

Tracy is upgrading the WWTP to improve treatment and expand capacity. The treatment system capacity will be expanded from 10.8 million gallons per day (mgd) to 16 mgd through a four-phase expansion. In order to increase discharge capacity, Tracy is planning to construct a second outfall, Discharge Point 002, approximately 800 feet downstream of Discharge Point 001. Tracy is currently proposing to build a desalination plant (Verma pers. comm.). Tracy released a public draft of the initial study/mitigated negative declaration (IS/MND) for the Tracy Desalination and Green Energy Project in December 2011 and final document in April 2012 (State Clearinghouse Number 2011122004).

Deuel Vocational Institution

The California Department of Corrections and Rehabilitation's (CDCR) current NPDES permit (Order No. R5-2014-0014) authorizes treated effluent discharges from the Deuel Vocational Institution. Deuel has general population housing of more than 3,700 inmates. Treated effluent is discharged into the Deuel Drain, which is tributary to Paradise Cut and Old River (Central Valley Water Board 2014a). The western end of Paradise Cut discharges to Old River.

Table 13-12 summarizes the WWTP NPDES permit enforcement orders showing violations of EC effluent limitations occurring during the existing NPDES permit term. Deuel has had 16 violations of its daily and monthly average EC effluent limitations since the existing NPDES permit was issued.[15] These violations are potentially attributed to a malfunction of the RO and Brine Concentrator systems used by the facility to reduce the salinity of the groundwater supply. The RO system has only operated for 16 months of the 48 months since it has been permitted to operate (i.e., it has operated 33percent of the time) (Central Valley Water Board 2015a).

Salinity Reduction Efforts

Source Water Supplies

Source water for Deuel comes from four on-site groundwater wells. The groundwater is treated prior to use via a RO system. Approximately 8,000 gallons per day of brine solution are removed and deposited to four evaporation ponds. Despite efforts to reduce salinity using this system, the facility continues to violate its effluent limitations; therefore, modifications to this facility are likely needed.

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[15] ACLC R5-2014-0518 and ACLC 2014-0550 were issued in 2014 and cover violations that occurred March 1, 2011 through December 31, 2013, and January 1, 2014 through March 31, 2014, respectively. However, EC was not one of the constituent standards that was in violation (Central Valley Water Board 2014a).

Salinity Pretreatment Program

Deuel does not have a pretreatment program because the only source of wastewater is the prison, and it does not treat industrial wastewater.

Table 13-12. Recent Wastewater Treatment Plant National Pollution Discharge Elimination System Permit Enforcement Orders for the Deuel Vocational Institution

Enforcement Order for EC Violation	Dates of Noncompliance	Description
Cease and Desist (R5-2008-0165-01) as amended by Administrative Civil Liability Complaint (ACLC) (R5-2010-0010)	NA	Established new interim daily EC limit of 3.000 dS/m (3,000 µmhos/cm) effective until Dec 31, 2010
ACLC (R5-2009-0571)	April 30, 2009	1 violation of daily EC limit of 3.000 dS/m (3,000 µmhos/cm)
ACLC (R5-2010-0526)	Aug 31, 2009–Feb 28, 2010	1 violation of monthly EC limit of 0.700 dS/m (700 µmhos/cm); 3 violations of monthly EC limit of 0.700 dS/m (700 µmhos/cm)
ACLC (R5-2010-0549)	April 30, 2010–Aug 31, 2010	5 violations of monthly EC limit of 0.700 dS/m (700 µmhos/cm)
ACLC (R5-2011-0575)	Sept 30, 2010–Feb 28, 2011	6 violations of monthly EC limit of 1.000 dS/m (1,000 µmhos/cm)

NA = not applicable
EC = electrical conductivity (salinity)
dS/m = deciSiemens per meter
µmhos/cm = micromhos per centimeter. Conversion is 1 dS/m = 1000 µmhos/cm.

City of Manteca

Manteca's current NPDES permit (Order No. R5-2015-0026) regulates tertiary treated effluent discharges from Manteca and surrounding areas and a portion of Lathrop. Manteca discharges part of its treated effluent to irrigated fields. The remaining treated effluent is discharged to the SJR just upstream of the Mossdale EC monitoring station and SJR at Brandt Bridge (C-6) (Central Valley Water Board 2015b). The discharge is approximately 20 miles from the nearest drinking water intake (Central Valley Water Board 2009). Manteca receives municipal wastewater and wastewater from a produce washing and processing facility (Eckert Cold Storage). However, the food processing wastewater is only discharged to land and enters the facility through a separate collection system.

After the issuance of Manteca's former (2004) NPDES permit (Order No. R5-2004-0028), which included seasonal effluent limits for EC of 1.0 dS/m (September–March) and 0.7 dS/m (April–August), Manteca petitioned the State Water Board to amend the 0.7 dS/m effluent limit. On March 16, 2005, the State Water Board adopted Water Quality Order (WQO) 2005-005, which removed the 0.7 dS/m EC effluent limit. In October 2009, the Central Valley Water Board adopted Manteca's last NPDES permit (Order No. R5-2009-0095) that again included seasonal effluent limits for EC of 1.0 dS/m (September–March) and 0.7 dS/m (April–August)[16]. Since Manteca could not consistently comply with the 0.7 dS/m limitation, the Central Valley Water Board also adopted a time schedule order (No. R5-2009-0096), allowing Manteca until October 2014 to achieve compliance with the seasonal 0.7 dS/m effluent limitation. The time schedule order also required Manteca to update its salinity PPP, initially developed in 2005. Manteca submitted a revised PPP in April 2010. Under Order No. R5-2015-0026, effluent limitations based on the Delta salinity objectives were not imposed due to the *City of Tracy v. State Water Resources Control Board* litigation. Instead, a salinity effluent limitation based on current performance was imposed (calendar year annual average for EC is not to exceed 1.0 dS/m), as well as a continuing requirement to implement its PPP. The average EC of Manteca's wastewater effluent has not changed substantially over the past few years (Tables 13-7 and 13-8).

Salinity Reduction Efforts

Source Water Supplies

Manteca's groundwater supplies, and, consequently, their wastewater and treated effluent, have a high salt content. A portion of Manteca's water supply is pumped from groundwater wells with an EC level range of 0.3 dS/m to 0.6 dS/m. Starting in 2005, Manteca substituted a portion of its groundwater supply with surface water from the SSJID such that Manteca's water supplies are currently comprised of 50 percent surface water. Manteca is currently evaluating the possibility of installing salinity-removal technologies at some or all of its groundwater wells (City of Manteca 2010).

Salinity Pretreatment Program

A source of wastewater salinity is self-regenerating water softeners (City of Manteca 2010). In recent years, Manteca's water supply has reduced its water hardness by obtaining different source water (e.g., surface water), but the use of water softeners has not decreased significantly because most water softener systems were installed in homes prior to the water hardness reduction. In the 2010 PPP, Manteca proposed to launch an education campaign to encourage residents to switch from standard self-regenerating water softeners to high-efficiency water softeners or an exchange tank system.

Several Manteca commercial and industrial wastewater generators participate in the current wastewater pretreatment processes and have undertaken efforts to reduce salinity. For example, the wastewater from Eckert Cold Storage has been separated into two streams, one for the food-processing and one for all other wastewater, thus reducing salinity discharged into the SJR.

Desalination at the WWTP

Manteca has not proposed to modify its facilities for salt removal.

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[16] Although the State Water Board removed the 0.7 dS/m EC limit in Manteca's 2004 NPDES permit, the Central Valley Water Board implemented the 0.7 dS/m EC limit again due to a subsequent State Water Board Order for the City of Tracy Wastewater Treatment Plant (WQO 2009-003).

City of Stockton

Stockton's current NPDES permit (Order No. R5-2014-0070) regulates tertiary treated effluent discharges from Stockton, the Port of Stockton, and surrounding urbanized San Joaquin County areas. The treated effluent is discharged to the SJR approximately 8 miles downstream from the SJR at Brandt Bridge compliance station (C-6) (Central Valley Water Board 2014b). There are no known drinking water intakes in the vicinity of the discharge (Central Valley Water Board 2014b). The average EC of Stockton's wastewater effluent has not changed substantially over the past few years (Tables 13-7 and 13-8). Stockton submitted a PPP to the Central Valley Water Board in 2005 and a draft salinity plan in June 2009. The average annual effluent is approximately 1.1 dS/m as stated in the 2011 salinity plan progress report based on effluent data collected from January to October 2010. These effluent data demonstrate compliance with the average annual salinity effluent limitation of 1.3 dS/m.

Salinity Reduction Efforts

Source Water Supplies

Stockton's existing water supply originates from groundwater wells, groundwater delivered by the California Water Service Company, and surface water delivered by SEWD from the Stanislaus and Calaveras Rivers. The average EC of the groundwater sources is approximately 0.5 dS/m (city wells) and approximately 0.4 dS/m (California Water Service wells), compared to 0.1 dS/m for surface water sources (City of Stockton 2009). The Delta Water Supply Project (DWSP) was completed in June 2012 and provides a new supplemental surface water supply from the SJR and includes a 30-mgd water treatment plant (City of Stockton 2011b).

Salinity Pretreatment Program

The extent of water softener use by Stockton residences is unknown (City of Stockton 2009). Stockton works with industrial dischargers within its service area to reduce TDS concentrations as part of its standard pretreatment program (City of Stockton 2009).

Desalination at the WWTP

Stockton is in the process of modifying the treatment plant to reduce salinity generated by alum (a chemical used to consolidate, and hence aid in the removal of, salt during the wastewater treatment process). It also will submit an inflow and infiltration study to the Central Valley Water Board as part of the capital improvement program to identify specific methods of reducing EC and TDS loads (City of Stockton 2011b).

Mountain House Community Services District

The Mountain House CSD's NPDES permit (Order No. R5-2013-0004) covers the discharge of tertiary treated effluent from the community of Mountain House in San Joaquin County into Old River (Central Valley Water Board 2013). The Jones Pumping Plant is located 4.5 miles west (downstream) of the discharge. The average EC of Mountain House CSD's wastewater effluent has not changed substantially over the past few years; however, it has slightly increased (Tables 13-7 and 13-8).

Salinity Reduction Efforts

Source Water Supplies

Mountain House CSD's source water is surface water from the Clifton Court Forebay, which has an EC of less than 0.3 dS/m (Central Valley Water Board 2007b).

Salinity Pretreatment Program

Mountain House CSD is required to implement a pretreatment program as specified in the current NDPES permit. Mountain House CSD continues to discourage the use of water softeners within its service area as part of its pretreatment program.

Desalination at the WWTP

Mountain House CSD currently neither operates a desalination system at the WWTP, nor does it plan to construct one.

Discovery Bay CSD

Discovery Bay CSD's NPDES permit (Order No. R5-2014-0073) regulates secondary treated discharges from the town of Discovery Bay to Old River (Central Valley Water Board 2014c). The Town of Discovery Bay owns the Discovery Bay WWTP, which serves approximately 16,000 people. Discovery Bay CSD's nearest compliance monitoring station is Clifton Court Forebay (2006 Bay-Delta Plan Station C-9). Bay-Delta Station C-9 is one of the four southern Delta salinity compliance stations and very little, if any, discharge from Discovery Bay CSD reaches the southern Delta (Marshall pers. comm. 2012b). However, because it is located within the southern Delta, it is included here as part of baseline conditions. The nearest drinking water intake is CCWD's Old River Intake for Los Vaqueros Reservoir. The average EC of Discovery Bay CSD's wastewater effluent has not changed substantially over the past few years; however, it has slightly decreased (Tables 13-7 and 13-8).

Salinity Reduction Efforts

Source Water Supplies

Discovery Bay CSD currently does not have any plans to change the source of its water supplies.

Salinity Pretreatment Program

Discovery Bay CSD currently does not have any plans to implement a salinity pretreatment program.

Desalination at the WWTP

According to the Discovery Bay Wastewater Treatment Master Plan (Discovery Bay CSD 2012), an RO treatment facility would be constructed to meet an effluent EC goal of 1.0 dS/m. However, because of the estimated high costs, high energy usage, and associated environmental impacts, the Discovery Bay CSD concluded in the master plan that RO treatment would only be constructed and used if mandated by the State (Discovery Bay CSD 2012).

Water Suppliers

Drinking water supply intakes are located in the southern Delta. These include the Jones and Banks pumping plants of the CVP and SWP, respectively, and the intakes for CCWD.

Central Valley Project and State Water Project

As described in Chapter 2, *Water Resources* (Section 2.6.2), and Chapter 5, *Surface Hydrology and Water Quality* (Sections 5.2.8 and 5.3.2), CVP and SWP export pumping is subject to 2006 Bay-Delta Plan objectives, which are implemented through the State Water Board's Water Right Decision 1641 (D-1641). Both the CVP and the SWP have maximum permitted pumping rates but are limited by water availability depending on precipitation, snowpack, and senior water rights holders' needs. Delta outflow requirements may also limit export pumping if the combined Delta inflow is not enough to satisfy both the in-Delta agricultural diversions and CVP and SWP pumping. The 1986 Coordinated Operations Agreement (COA) between the federal and state governments sets the rules by which the CVP and SWP jointly operate their water storage and conveyance facilities in order meet regulatory obligations, maximize their contractual water deliveries, including Delta export pumping, and not adversely affect each other's water rights or the rights of others.

Contra Costa Water District

The CCWD diverts water from the southern and central Delta for drinking water supplies to eastern and central Contra Costa County. As described in Chapter 2, *Water Resources*, CCWD has four surface water intakes: Mallard Slough Intake, Rock Slough Pumping Plant #1, Old River Intake near State Route (SR) 4, and the Victoria Canal Intake. Old River and Victoria Canal Intakes are located immediately north–northwest of the SDWA boundary (Figure 2-12). The Mallard Slough Intake and Rock Slough Intake are located further west and closer to the ocean. The Old River Intake is the largest intake operated and accounts for the majority of surface water diverted to CCWD (CCWD and USBR 2008.)

CCWD's rights to divert water from the Delta integrate CCWD's operations with the coordinated operations of the CVP and SWP. CCWD has a contract with USBR for the delivery of 195,000 acre-feet per year (AF/y) of CVP water for municipal and industrial uses and agricultural users in the CCWD service area. The water delivered under the contract may be diverted at the Rock Slough and Old River intakes at any time of the year. CCWD also has a water right for the Los Vaqueros Project that allows water to be diverted from Old River to Los Vaqueros Reservoir November–June during excess conditions in the Delta as defined in D-1629. CCWD also has a license and permit for diversions at Mallard Slough for up to 26,780 AF/y. Therefore, when CCWD operates within the terms of its CVP contract and water rights permits, it does so in conjunction with all other water supply interests (CCWD and USBR 2008).

CCWD's intakes are located in the western Delta where the effects of seawater intrusion are more pronounced. Generally, CCWD's intakes experience relatively fresh conditions in the late winter and early spring, and salinity increases in summer and fall as conditions become drier and regulatory standards governing Delta operations shift. This pattern can vary depending on hydrology (CCWD and USBR 2008). Use of the Mallard Slough Intake is generally restricted due to salinity concentrations because it experiences more tidal fluctuations as a result of its location. Water quality conditions have restricted diversions from Mallard Slough (an average of 3,100 AF/y) with no diversions available in dry years. When Mallard Slough supplies are used, CVP diversions at Rock Slough are reduced by an equivalent amount. The Victoria Canal Intake allows CCWD the flexibility to divert water with lower salinity and allows seasonal operations shifts between diversions. The seasonal variation in salinity between Old River/Rock Slough and Victoria Canal allows CCWD to divert predominantly in winter and spring from Old River. In the late summer, as salinity begins to rise, Victoria Canal salinity is generally lower than Old River salinity and remains lower until Delta outflow increases and Delta salinity improves (usually in December). Thus, CCWD typically diverts water in the summer and fall from Victoria Canal (CCWD and USBR 2008).

13.3 Regulatory Background

13.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to service providers are described below.

Safe Drinking Water Act

The Safe Drinking Water Act (42 U.S.C., § 300f et seq.), originally passed by Congress in 1974 and amended in 1986 and 1996, was established to protect public health by regulating the nation's public drinking water supply. In addition to drinking water itself, the act requires the protection of its sources, such as rivers, lakes, reservoirs, springs, and groundwater wells. The act authorizes the U.S. Environmental Protection Agency (USEPA) to set national health-based standards for drinking water, such as MCLs, to protect against contaminants that may adversely affect public health. In California, as of July 1, 2014, the State Water Board's DDW implements the Safe Drinking Water Act. Included under the regulatory portion of the DDW program are: (1) issuance of permits for public water systems and their sources and treatment to ensure compliance with drinking water standards, (2) inspection of water systems, (3) tracking of monitoring requirements of water systems to determine compliance, and (4) enforcement actions.

The Safe Drinking Water Act mandates that all community water systems, regardless of water source (i.e., groundwater versus surface water) prepare and distribute an annual water quality report, or CCR. The CCR must summarize information on system source water, detected regulated contaminants in the drinking water, compliance to restore safe drinking water, and educational information, particularly regarding nitrate, arsenic, or lead in areas where these naturally occurring contaminants may be of concern. CCRs must be distributed to community water system customers by July 1 each year and the reports provide information on water quality for the preceding calendar year.

Clean Water Act

The federal CWA (33 U.S.C., § 1251 et seq.) places primary responsibility for developing water quality standards on the states. The CWA established the basic structure for regulating point and nonpoint discharges of pollutants into the waters of the United States and gave USEPA the authority to implement pollution control programs, such as setting wastewater standards for industry. The statute employs a variety of regulatory and non-regulatory tools to reduce pollutant discharges into waters of the United States, finance municipal wastewater treatment facilities, and manage polluted runoff.

Clean Water Act Section 402

Section 402 of the CWA regulates point-source discharges to surface waters through the NPDES program, which is administered by USEPA. In states with approved programs, like California, the State Water Board and the regional water boards have the primary responsibility to apply and enforce the requirements of the CWA as a substitute for direct regulation by USEPA (33 U.S.C. §§ 1342, subs. (b), (c); see related discussion of the Porter-Cologne Water Quality Control Act in Section 13.3.2, *State [Regulatory Background]*). The NPDES program provides for both general permits (those that cover a number of similar or related activities) and individual permits. Typically, NPDES permits are reissued every 5 years (see Table 13-7 for recent permit information of WWTPs within the area of potential effects). WWTPs are required to obtain NPDES permits that contain specific requirements limiting discharge pollutants for the discharge of treated wastewater. NPDES permits also require dischargers to monitor their wastewater to ensure treated effluent meets all permitted requirements. The Central Valley Water Board generally issues WWTP NPDES permits for wastewater discharges within the area of potential effects.

13.3.2 State

Relevant state programs, policies, plans, or regulations related to service providers are described below.

California Code of Regulations, Title 23

Title 23 of the California Code of Regulations contains the State Water Board's regulations. Section 106 identifies the policy of the state that the use of water for domestic purposes is the highest use, with irrigation being the next highest use. Section 106.3 identifies that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes (also known as the "Human Right to Water"). Relevant state agencies, including the State Water Board, need to consider the human right to water when revising, adopting, or establishing policies and regulations relevant to domestic water use.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) (Wat. Code, § 13000 et seq.) establishes a comprehensive program for the protection of water quality. It addresses both point and non-point discharges to surface and ground waters. It provides for a statewide program for water quality control administered regionally, within a framework of statewide coordination and policy. (Wat. Code, § 13000.) The nine regional water boards have primary responsibility for permitting through waste discharge requirements, inspection and enforcement actions. (See Wat. Code, §§ 13260 et seq. and 13300 et seq.) The Porter-Cologne Act provides for the adoption of water quality control plans. (Wat. Code, §§ 13170, 13240 et seq.) The State Water Board and the regional water boards administer the CWA's NPDES permit program, with oversight from USEPA. (See Wat. Code, §§ 13370 et seq.) The State Water Board is updating the 2006 Bay-Delta Plan in accordance with the CWA and the Porter-Cologne Act.

Given the authority under the Porter-Cologne Act to protect water quality, the State Water Board can take various actions to respond to areas with water quality concerns. For example, in enforcement actions, it can order parties responsible for nitrate contamination to provide replacement water to impacted communities, as appropriate. Since 2014, the State Water Board has assisted regional water boards with negotiating replacement water orders, including bottled water and reverse-osmosis treatment, for nitrate-impacted drinking water.

San Francisco Bay/Sacramento–San Joaquin Delta Estuary Water Quality Control Plan

The 2006 Bay-Delta Plan was adopted by the State Water Board in December of 2006 following a review of the 1995 Bay-Delta Plan. The 2006 Bay-Delta Plan identifies beneficial uses of the Bay-Delta, water quality objectives (i.e., flow and salinity) for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives.

The numeric objectives for EC in the 2006 Bay-Delta Plan for the southern Delta are based on the protection of agricultural beneficial uses, which is 100 percent protection of salt-sensitive bean and alfalfa crops (Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*). The numeric objectives are 0.7 dS/m during the summer irrigation season (April–August) and 1.0 dS/m during the winter season (September–March). Compliance with these objectives is currently monitored at four compliance locations: SJR at Vernalis (C-10), SJR at Brandt Bridge (C-6), Old River near Middle River (C-8), and Old River at Tracy Boulevard Bridge (P-12). The numeric objectives are not just applicable at the compliance monitoring locations, but they also apply to the receiving waters of WWTP discharge: “unless otherwise indicated, water quality objectives cited for a general area, such as for the southern Delta, are applicable for all locations in that general area, and compliance locations will be used to determine compliance with the cited objectives” (State Water Board 2006).

D-1641 contains the current water right requirements, applicable to the California Department of Water Resources’ (DWR’s) and the U.S. Bureau of Reclamation’s (USBR’s) operations of the SWP and CVP facilities, to implement the Bay-Delta water quality objectives. It requires that USBR release flows from New Melones Reservoir to maintain EC at Vernalis. The salinity objectives are the maximum 30-day running average (monthly average) of mean daily EC (0.700 dS/m April–August and 1.0 dS/m September–March for all water year types) (State Water Board 2006).

The existing objective for chloride concentration (related to salinity) is a year-round maximum mean daily chloride concentration of 250 mg/L measured at five Delta intake facilities, of which CCWD’s Pumping Plant No. 1 is one, for the reasonable protection of municipal beneficial uses. This is consistent with USEPA’s secondary MCL for chloride. Additionally, a maximum daily chloride concentration of 150 mg/L (measured either at Pumping Plant No. 1 or the SJR at the Antioch Water Works Intake) is included in the 2006 Bay-Delta Plan for the reasonable protection of industrial uses. A water quality goal for bromides (related to salinity) is set at 0.15 mg/L.

Sacramento River and San Joaquin River Basins Water Quality Control Plan

The Central Valley Water Board’s *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* identifies the beneficial uses to be reasonably protected in the Sacramento and SJR Basin water bodies, water quality objectives, implementation programs, and surveillance and monitoring programs. It includes wasteload allocations for salt and boron discharges into the LSJR. The waste load allocations are the concentration limits set equal to the EC water quality objectives for the SJR at the Airport Way Bridge near Vernalis. The Central Valley Water Board implements the plan by issuing WDR or NPDES permits for wastewater discharges. Southern Delta dischargers have been issued NPDES permits for treated discharges and are listed in Table 13-7.

The plan incorporates, by reference, the State Water Board's DDW's (formerly part of the California Department of Public Health (DPH) numerical drinking water maximum contaminant levels (MCLs). The incorporation of the MCLs, which apply to treated drinking water systems regulated by the DDW, makes the MCLs also applicable to ambient receiving water with respect to the regulatory programs administered by the regional water boards.

The Central Valley Water Board also adopted, and the State Water Board approved, plan amendments to add policies for variances from surface water quality standards for point source dischargers, a variance program for salinity, and exception from implementation of water quality objectives for salinity.[17] The amendments are pending approval by USEPA before they become effective. Under the variance policy, the Central Valley Water Board would be allowed the authority to grant variances from meeting water quality-based effluent limitations for non-priority pollutants to dischargers subject to NPDES permits. Under the salinity variance program, domestic and municipal wastewater permittees subject to NPDES permits may apply to the Central Valley Water Board for a variance from meeting water quality-based effluent limitations for salinity constituents (i.e., EC, total dissolved solids, chloride, sulfate and sodium). The Central Valley Water Board may approve the permittee's salinity variance request for a period not exceeding ten years after finding, among other things, that the attainment of water-quality based effluent limitations for salinity is not feasible, the permittee has implemented or will implement feasible salinity reduction/elimination measures and permittee continues to participate in the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) effort, a stakeholder effort working to develop comprehensive salt and nitrate management plans. Under the salinity exception program, dischargers that are subject to WDRs that are not also NPDES permits and conditional waivers may obtain a limited-term exception to discharge requirements from the implementation of water quality objectives for salinity. SDWQ Alternatives 2 and 3 are subject to the variance policy, salinity variance program and salinity exception program adopted by the Central Valley Water Board under Resolution No. R5-2014-0074.

California Drinking Water Standards

The California drinking water standards are based on federal standards, which are listed in Title 22 of the California Code of Regulations and administered by the State Water Board's DDW. California MCLs, components of drinking water standards, are found in Title 22, Chapter 15, Division 4. Salinity can affect the taste, corrosivity, and other non-health-related characteristics of drinking water supplies. Drinking water has a recommended secondary MCL for specific conductance (i.e., salinity) of 0.900 dS/m. The upper secondary MCL is 1.600 dS/m and a short-term secondary MCL is 2.200 dS/m. No fixed consumer acceptance contaminant level has been established for conductance. Specific conductance concentrations lower than the recommended secondary MCL are desirable for a higher degree of consumer acceptance. The secondary MCL can be exceeded and is deemed acceptable to approach the upper MCL if it is neither reasonable nor feasible to provide more

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[17] See *Central Valley Regional Water Quality Control Board Resolution No. R5-2014-0074* and *State Water Board Resolution No. 2015-010*.

suitable waters. In addition, concentrations ranging up to the short-term MCL are acceptable only for existing community water systems on a temporary basis.

California Safe Drinking Water Act

The California Health and Safety Code (Part 12, Chapter 4) defines public water systems as a system for the provision of water for human consumption through pipes or other constructed conveyance that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. A public water system includes the following.

- Any collection, treatment, storage, and distribution facilities under control of the operator of the system that are used primarily in connection with the system.
- Any collection or pretreatment storage facilities not under the control of the operator that are used primarily in connection with the system.
- Any water system that treats water on behalf of one or more public water systems for the purpose of rendering it safe for human consumption.

The Safe Drinking Water Act (at Health and Safety Code Section 116270 et seq.) includes the following summarized provisions regarding the controls to prevent contaminated water from getting to the end user of a public water system.

- Section 116287—DDW must place requirements on public water systems and water districts that are consistent with both the state and federal SDWA.
- Sections 116325 and 116350—DDW is responsible for ensuring that all public water systems are operated in compliance with the act and its regulations to protect public health.
- Section 116365—DDW must adopt primary drinking water standards for contaminants in drinking water that are not less stringent than the federal Safe Drinking Water Act.
- Section 116385—public water systems have to provide water analysis to DDW.
- Section 116395—DDW must assist local health officer in the evaluation of small public water systems for potential organic chemical contamination.
- Section 116400—if DDW determines a public water system is subject to potential contamination, it may require quarterly water analysis.
- Section 116425—DDW may exempt public water systems from any MCL or treatment requirements under certain compelling factors and other criteria, but only if it will not result in an unreasonable risk to health. Exemptions are granted for 12 months, but can be extended be up to 3 years if specific criteria are met.
- Section 116450—when primary drinking water standards are exceeded the public system operator has to notify DDW and users.
- Section 116470—public water systems are required to prepare and deliver consumer confidence reports; systems serving 10,000 service connections must disclose detections of contaminants and best available technologies to address the contamination.
- Section 116525 and 116540—operators of a public water system may not operate without a DDW permit. DDW may impose permit conditions, requirements for system improvements, and time schedule to ensure a reliable and adequate supply of water that is at all times pure, wholesome, potable, and does not endanger the health of consumers.

- Section 116550—public water systems may not change its source of supply or method of treatment without an amended permit.
- Section 116555—public water systems must comply with primary and secondary drinking water standards and provide pure, wholesome, healthful and potable water, among other requirements.
- Section 116655—DDW may issue compliance orders, which can include without limitation requiring treatment/purification, change in source water, or system repairs.

Detailed requirements for regular water quality monitoring are set forth in DDW's regulations at Cal. Code. Regs., tit. 22, Section 64400 et seq.

State Water Board Sources of Drinking Water Policy (Resolution No. 88-63)

The Sources of Drinking Water Policy (Resolution No. 88-63) established state policy that regional water boards must consider all surface water and groundwater, with certain exceptions, as suitable or potentially suitable for municipal or domestic supply. The policy defines the following three categories of waters potentially eligible for an exception from the designation and protection of a water source for municipal or domestic supply.

- Water bodies with high salinity (defined as TDS >3,000 mg/L), that either have naturally high contaminant levels that cannot reasonably be treated using either best management practices (BMPs) or best economically achievable treatment practices, or produce too low yield (<200 gallons per day).
- Waters designed or modified to treat wastewaters (domestic or industrial wastewater, process water, stormwater, mining discharges, or agricultural drainage), provided that such systems are monitored to ensure compliance with all relevant water quality objectives.
- Groundwater aquifers regulated as geothermal energy-producing sources or aquifers that have been exempted administratively by federal regulations for the purpose of underground injection of fluids associated with the production of hydrocarbon or geothermal energy.

Groundwater Ambient Monitoring and Assessment Program

GAMA is a comprehensive groundwater quality monitoring program based on interagency collaboration between the State Water Board, regional water boards, DWR, Department of Pesticide Regulations, U.S. Geological Survey, and Lawrence Livermore National Laboratory (LLNL), and cooperation with local water agencies and well owners. Developed by the State Water Board in 2000, GAMA was expanded by the passage of the Groundwater Quality Monitoring Act of 2001, and includes the following four projects to meet the statutory requirements of the act.

- The Priority Basin Project—currently assesses the water quality of shallow aquifers typically used for domestic supplies prioritizing areas with the greatest household densities relying on domestic wells.
- GeoTracker GAMA—a groundwater information system that provides water quality data from multiple sources on an interactive Google-based map.
- Domestic Well Project—samples private wells on a county level for well owners who volunteer when the project is active in their county. Results are used by GAMA to evaluate water quality of domestic wells.

- Special Studies Project—focuses on groundwater studies conducted by LLNL, which cover nitrate, wastewater and groundwater recharge.

Groundwater Quality Monitoring Act of 2001

The Groundwater Quality Monitoring Act of 2001 was established to improve statewide comprehensive groundwater monitoring and to provide the public with readily available information about groundwater quality in California. The Groundwater Quality Monitoring Act requires that the State Water Board integrate existing monitoring programs and, as necessary, establish new program elements in order to create a comprehensive groundwater monitoring program for assessing the quality of all priority groundwater basin in the state that account for over 90 percent of groundwater used in California.

The Sustainable Groundwater Management Act

It is California state policy (Water Code § 113) that "groundwater resources be managed sustainably for long-term reliability and multiple economic, social, and environmental benefits for current and future beneficial uses" and that sustainable groundwater management "is best achieved locally through the development, implementation, and updating of plans and programs based on the best available science."

The Sustainable Groundwater Management Act (SGMA) (Wat. Code, § 10720 et seq.) provides the framework to implement this policy by requiring that local agencies in high- and medium-priority basins (DWR 2014) form groundwater sustainability agencies (GSAs) by June 30, 2017 that will develop, and commence implementation of, groundwater sustainability plans (GSPs) by either 2020 or 2022[18] that will achieve sustainable groundwater management within 20 years. SGMA defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the [50 year] planning and implementation horizon without causing undesirable results." SGMA's definition of undesirable results includes such effects as chronic lowering of groundwater levels, significant and unreasonable reductions in groundwater storage, degradations of water quality, and land subsidence that interferes with surface land uses. (Wat. Code, § 10721, subd. (x).)

SGMA recognizes regional differences and provides flexibility to local agencies to tailor plans that meet their needs, improves coordination between land use and groundwater planning, prioritizes basins with the greatest problems and protects water rights. The legislation provides two key management principles: It ensures that local and regional agencies have the resources they need to sustainably manage groundwater, including the necessary authority, better technical information, and financial resources; and, when local agencies cannot or will not manage their groundwater sustainably, the legislation provides for State Water Board intervention until local agencies develop and implement sustainable groundwater management plans.[19] SGMA is described in greater detail in Chapter 9, *Groundwater Resources.*

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[18] SGMA requires critically overdrafted high and medium priority basins (as determined by DWR), to adopt GSPs by January 31, 2020. In the plan area this includes the Eastern San Joaquin, Merced and Chowchilla Subbasins. All other high and medium priority basins, such as the Modesto and Turlock Subbasins, must develop GSPs by January 31, 2022.

[19] The State Water Board can only intervene in a local area and develop an interim plan in limited circumstances: when no agency is willing to serve as a GSA (by 2017); when a GSA does not compete a GSP (by 2020); and when

13.3.3 Regional or Local

Relevant regional or local programs, policies, plans, or regulations related to service providers are described below. Although local policies, plans, or regulations are not binding on the state of California, below is a description of relevant ones.

Agricultural Water Management Plans

Several of the irrigation districts have prepared agricultural water management plans (AWMPs), in which they have identified methods for dealing with water supply shortages. Table 13-13 describes methods that are common throughout all of the irrigation district AWMPs for addressing surface water shortages.

Table 13-13. Irrigation District Methods for Addressing Surface Water Shortages

Irrigation District	Conjunctive Use	Reduction in Surface Water Allotments	Allowable Internal Transfers	Groundwater Used for Permanent Crops	Holds Carryover Surface Water for Crops	All Shortages Managed with Groundwater	Fair and Equitable Distribution	USBR Responsible for Shortages
SSJID	X	X	X	NA	NA	NA	X	X
OID	X	X	X	X	NA	NA	X	X
SEWD	X	X	NA	NA	NA	NA	NA	X
TID	X	X	X	X	X	NA	NA	NA
MID	X	X	NA	X	X	NA	NA	NA
Merced ID	X	X	NA	X	X	NA	X	NA

Sources: SSJID 2011, 2012; SEWD 2014; City of Stockton 2011c; OID 2012; TID 2012; MID 2012; Merced ID 2013; City of Merced 2001.

NA = not applicable

Urban Water Management Plans

The California Urban Water Management Planning Act requires urban water suppliers[20] to initiate planning strategies to ensure the appropriate level of reliability in their water service sufficient to meet the needs of the various categories of customers during normal, dry, and multiple dry water years. To do this, they must prepare an urban water management plan (UWMP) every 5 years. The intent of the UWMP is to present information about water supply, water usage, recycled water, and water use efficiency programs in a contracting water district's service area. The UWMP also serves as a resource for planners and policy makers over a 25-year planning time frame. Below is a brief summary of information contained in the UWMPs that are available for SSJID and MID and for entities that receive surface water from the irrigation districts.

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both the GSP is inadequate or not implemented to achieve sustainability, and there is a condition of long-term overdraft or significant depletion of interconnected surface waters.

[20] *Urban water suppliers* are defined as suppliers that have 3,000 or more water connections or provide over 3,000 acre-feet of water annually.

South San Joaquin Irrigation District (SSJID)

SSJID is contracted to provide surface water to SEWD and the Cities of Tracy, Manteca, Lathrop, Ripon, and Escalon. In 2005, these cities, with the exception of Ripon, partnered with SSJID to construct a water treatment plant and pipeline to deliver treated water from the Woodward Reservoir to these participating cities as part of the South County Water Supply Project. The Cities of Manteca and Lathrop will receive 18,500 AF/y and 11,791 AF/y of treated potable water, respectively, once Phase II of the South County Water Supply Project is implemented (City of Lathrop 2009; City of Manteca 2012b).

SSJID's water comes from three sources: the Stanislaus River, groundwater pumping by SSJID and private land owners, and irrigation return flows from neighboring districts. The primary water supply is surface water diversions from the Stanislaus River. The majority of water users in the service area are agricultural, but the cities contracted with SSJID do serve municipal and urban users. SSJID projects it will have adequate supplies to meet water demands in normal years through 2030 (dependent upon the certainty of the available water supply, which is dependent upon each year's hydrology and regulatory uncertainty). SSJID would experience water shortages under single dry year conditions through 2030 that could not be compensated by conservation and only minimal shortages under multiple dry year conditions through 2030 that could likely be compensated by conservation (SSJID 2011).

Stockton East Water District (SEWD)

SEWD serves both urban and agricultural water users. SEWD's receives surface water from both the Stanislaus River (within the plan area) and Calaveras River (outside of the plan area). SEWD typically receives 75,000 AF/y from New Melones Reservoir on the Stanislaus River and under the OID/SSJID water transfer agreement, 8,000 to 30,000 AF/y[21]. SEWD typically receives approximately 56.5 percent of its water supply from New Hogan Reservoir on the Calaveras River. As such, based on total surface water supplies received in 2010 (118,216 AF): 51,540 AF (approximately 44 percent of the total) came from New Melones Reservoir for agricultural use; 26,900 AF (approximately 23 percent of the total) came from the OID/SSJID water transfer agreement; and the New Hogan Reservoir provided 39, 776 AF of water (approximately 34 percent of the total) for urban use (SEWD 2014). SEWD maintains two groundwater wells that are only pumped to supplement demand during dry years. Saline intrusion and contamination from agricultural chemicals limit the use of groundwater. The *Stockton East Water District Water Management Plan* (SEWD 2014) includes the existing and projected water demands associated with these water users. SEWD's Water Management Plan identifies that deficiencies in water supply would occur under normal, single dry, and multiple dry years and would be offset by additional groundwater pumping from urban retailers and the DWSP (SEWD 2014).

City of Tracy

Tracy obtains water from both surface and groundwater sources. The amount of water that Tracy uses from each source varies year to year based on contractual agreements, annual precipitation, and city policy (City of Tracy 2011a). Currently, Tracy's existing water supplies include 17,500 AF/y through

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[21] This agreement is based on New Melones Reservoir storage and inflow as of April 1 of each year. This contract ended in 2009, with a potential 10-year renewal, pending studies. A one-year temporary water transfer agreement for the water year 2009–2010 allowed for a sale of up to 15,000 AF/y from both OID and SSJID.

the USBR CVP Interim Renewal Contract; 2,500 AF/y via USBR WSID Option; and 11,120 AF/y from the South County Water Supply Project (City of Tracy 2014). Tracy Hills, once built out, will receive 2,430 AF/y from Byron Bethany Irrigation District (City of Tracy 2014). The City of Tracy is planning to decrease groundwater use to 2,500 AF/y by 2015; however, up to 9,000 AF/y of groundwater is available to the City of Tracy to make up for shortfalls in the event of a severe drought or other water shortage (City of Tracy 2014). Tracy anticipates that it has sufficient water supply to meet the water demand through 2035 during normal years, single dry and multiple dry years.

City of Ripon

Ripon last prepared an UWMP in 2003 and updated it in 2011 to meet new state standards. Ripon has an agreement with SSJID to receive 2,000 AF/y, with a gradual increase to 6,000 AF/y by 2030 (SSJID 2011).

City of Modesto and Modesto Irrigation District (MID)

Modesto relies on a conjunctive water use strategy with two primary sources: groundwater and surface water from the Tuolumne River purchased from MID. During normal water years, MID delivers approximately 33,600 AF/y of treated surface water to the City of Modesto. This amount is projected to increase to approximately 67,000 AF/y by 2035. Groundwater use is expected to be reduced in the future with the introduction of additional surface water supplies from the Modesto Regional Water Treatment Plant (MRWTP), and this supply source will become Modesto's primary water supply, with groundwater supplementing the available surface water supplies to meet demand (City of Modesto and MID 2011). The Phase Two expansion of MRWTP will double the capacity of MID's water treatment plant, and an additional 33,602 AF/y of demand will be met with surface water supplies upon the completion of this expansion.

The surface water supplied by the MRWTP is provided through agreements with MID, and if it becomes necessary to reduce deliveries to its landowners, there would be proportional reductions to the City of Modesto. The City of Modesto and MID project that water demand will be met 100 percent of the time with the water supply in normal, single dry, and multiple dry years, through 2035. In general, projected demand is expected to be met through additional groundwater pumping (City of Modesto and MID 2011).

City and County of San Francisco (CCSF)

The CCSF regional water system obtains approximately 85 percent of its water from the Upper Tuolumne River Watershed, which is collected in Hetch Hetchy Reservoir. The remaining 15 percent of CCSF's water supply is obtained from surface water sources in the Alameda and San Francisco Peninsula Watersheds (SFPUC 2013). In 2015, CCSF provided approximately 196 mgd of surface water to approximately 1,800,897 wholesale and 847,370 retail customers, and an additional 2 mgd of groundwater and recycled water was also delivered to retail customers (SFPUC 2016). The amount of water available to CCSF varies from year-to-year depending on meteorological conditions, water rights, and statutory and contractual obligations (City and County of San Francisco 2008). Currently, groundwater use is generally limited to irrigation in Golden Gate Park and at the San Francisco Zoo (City and County of San Francisco 2008). However, ongoing groundwater storage projects including the Regional Groundwater Storage and Recovery Project (as part of the WSIP, discussed below) and the San Francisco Groundwater Supply Project, would increase water supply reliability and diversify CCSF's water supply (SFPUC 2015).

In normal water years water demand is met 100 percent of the time. At current delivery levels, CCSF expects to experience up to a 25 percent water supply shortage 15–20 percent of the time during multiple-year droughts. To enhance the ability of CCSF to meet service goals for water supply, as well as water delivery reliability, water quality, and seismic reliability, SFPUC is implementing the Water System Improvement Program (WSIP). The WSIP is, in part, a water supply program that will be implemented in phases to meet projected water purchases through 2030 in drought and normal water years. The WSIP establishes a mid-term planning milestone for 2018 at which point SFPUC would reevaluate water demand projections through 2030 in the context of information, analysis and available water resources in 2018. The WSIP includes the following water supply elements.

- Water supply delivery to regional water system customers through 2018 of 265 mgd average annual target delivery, which includes 184 mgd for wholesale customers and 81 mgd for retail customers;
- Water supply sources would include 265 mgd average annual from Tuolumne River, San Francisco Peninsula, and Alameda Creek Watersheds, and 20 mgd (divided evenly between retail and wholesale customers) of water conservation, recycled water and local groundwater developed within the SFPUC's service area; and
- Water supply projects to meet dry-year demands with no greater than 20 percent system-wide rationing in any one year, which would include restoring the capacity of Calaveras and Crystal Springs reservoirs; groundwater conjunctive use; and water transfers with MID and TID during dry years (average 2 mgd) (CCSF 2008).

Delta Regional Monitoring Program

Since 2012, the Delta Regional Monitoring Program (Delta RMP), initiated by the Central Valley Water Board, has had the main goal of tracking and documenting the effectiveness of beneficial use protection on restoration efforts through comprehensive monitoring of water quality constituents in the Delta. The Delta RMP is stakeholder-directed with a steering committee consisting of publicly-owned WWTPs, municipal stormwater dischargers, the Central Valley Water Board, the USEPA, California Natural Resources Agency, State and Federal Contractors Water Agency, and Interagency Ecological Program. The Delta RMP is still under development.

Order R5-2014-0122 considers the amendment of NPDES permits of several Sacramento–San Joaquin Delta-area dischargers in accordance with 40 CFR 122.62(a)(2), including the City of Stockton Regional Wastewater Control Facility; the City of Tracy WWTP; Mountain House CSD; Discovery Bay CSD; and Deuel Vocational Institution to allow for the participation in the Delta RMP in lieu of conducting their current individual monitoring efforts, when feasible and appropriate.

General Plans

City and county general plans can contain policies governing service providers, specifically with respect to water supply and wastewater. The goals and policies governing service providers within the area of potential effects are addressed in the applicable county general plans. Although local general plans are not binding on the state of California, relevant provisions of these county general plans are outlined below.

Stanislaus County

Goals and policies addressing water services and groundwater resources are presented in the *Stanislaus County General Plan Conservation and Open Space Element* (Stanislaus County 1995). These include: monitoring groundwater quality, preventing reduction of groundwater levels, and incorporating water conservation strategies into new development.

Merced County

Goals and policies addressing water services are presented in the *Public Facilities Element* and the *Water Element* of the *2030 Merced County General Plan* (Merced County 2013). The policies support the adequate provision of utilities to the residents of Merced County and ensure a reliable water supply sufficient to meet the existing and future needs of the county by implementing groundwater recharge projects, demonstrating sufficient water supply for new development, and investing in additional surface water storage opportunities.

San Joaquin County

Objectives and policies addressing water services and groundwater resources are presented in the *Resources Element* of San Joaquin County's general plan (San Joaquin County 1992). The objectives include obtaining sufficient supplemental water supplies to meet all municipal and agricultural needs; protecting groundwater resources from overdraft; and preventing water supply contamination. The policies discuss maintaining water quality and managing water resources such that conjunctive use and other groundwater and surface water management practices are undertaken.

Contra Costa County

Goals and policies addressing water services are presented in the *Contra Costa County General Plan Public Facilities/Service Element* section on water services (Contra Costa County 2005). These policies include assurance of meeting regulatory standards for water delivery, water storage, and emergency water supplies to residents. The general plan identifies goals of ensuring potable water availability in quantities sufficient to serve existing and future residents and ensuring that new development pays the costs related to the need for future increased water system capacity.

City of Tracy

The *Tracy General Plan Public Facilities and Services Element* contains policies stating that the approval of a new development is conditioned on the availability of sufficient wastewater collection and treatment capacity to service the proposed development. In addition, new development shall fully fund the cost of wastewater treatment and disposal facilities. Tracy's general plan contains objectives and policies generally stating that the City shall meet the demands of future development with adequate water supply and infrastructure. Policies also state that the City shall establish water demand reduction standards for new development (City of Tracy 2011c).

City of Stockton

The *2035 Stockton General Plan* contains policies that discuss the need for proper facility sizing to meet long-term needs, wastewater reuse, and protection of critical infrastructure. It also contains policies that reflect the City's need for facilities able to meet long-term demands (City of Stockton 2007).

City of Manteca

Goals and policies addressing water services and wastewater services are presented in the *City of Manteca's General Plan Public Facilities and Service Element* (City of Manteca 2003). Goals include maintaining existing target level of services for water delivery to residents and meeting the needs of existing and projected development. Policies to support the goals include principally relying on groundwater resources in the near term, developing new water sources as necessary to serve new development, ensuring water quality and preventing contamination, and developing and implementing water conservation measures.

City of Lathrop

Section D of the *Comprehensive General Plan for the City of Lathrop* provides guidance for the elimination of deficiencies in existing utility services and obstacles to the expansion of utility services to adequately serve existing and future development (City of Lathrop 2004). This guidance includes: developing and maintaining existing groundwater resources within city limits, participating in the South County Surface Water Supply Project, converting agricultural water entitlements, and obtaining rights to other water sources in the region.

City of Escalon

Goals and policies identified in the City of Escalon's general plan are meant to address the community need for public service and facilities (City of Escalon 2005). These goals and policies are meant to develop services and facilities, such as those for water supply, as the city grows and to plan for the future increase in demand for such services.

City of Ripon

Goals and policies identified in the *City of Ripon's General Plan Land Use and Growth Accommodations Element* are meant to address groundwater resources and water conservation as they relate to water supply (City of Ripon 2006). These include monitoring the existing groundwater conditions and supply, identifying and securing available sources of supplemental surface water for replacement or recharge of groundwater, and promoting water conservation.

13.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on service providers. It further describes the methods of analysis used to determine significance. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

13.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the board's California Environmental Quality Act (CEQA) regulations. (Cal. Code Regs., tit. 23, §§ 3720–3781.) The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Impacts resulting from actions by service providers were identified as potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis as to whether the alternatives could result in the following.

- Require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.
- Violate any water quality standards such that drinking water quality in (a) public water systems and (b) domestic wells would be affected.
- Result in substantial changes to SJR inflows to the Delta such that insufficient water supplies would be available to service providers relying on CVP/SWP exports.

Where appropriate, specific quantitative or qualitative criteria are described in Section 13.4.2, *Methods and Approach*, for evaluating these thresholds.

As described Appendix B, *State Water Board's Environmental Checklist,* the LSJR and SDWQ alternatives would result in either no impact or less-than-significant impacts on the following related to service providers and, therefore, are not discussed further within this chapter.

- Exceed wastewater treatment requirements of the applicable regional water quality control board.
- Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed.
- Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.
- Result in a determination by the wastewater treatment provider, which serves or may serve the project, that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments.
- Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs.
- Comply with federal, state, and local statutes and regulations related to solid waste.

13.4.2 Methods and Approach

LSJR Alternatives

This chapter evaluates the potential service provider impacts associated with the LSJR alternatives. Each LSJR alternative includes a specific unimpaired flow[22] requirement (i.e., 20, 40 or 60 percent) from February–June and different methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. Impacts could occur through a change in either surface water supply or groundwater supply or a change in surface or groundwater water quality under the LSJR alternatives. The methods for evaluating these changes and the potential impacts are detailed in the following sections.

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[22] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

Surface Water Supply

Results from the Water Supply Effects (WSE) model were used to estimate the potential surface water diversion reductions on each of the three eastside tributaries (Impact SP-1). Table 13-14 shows the changes in the cumulative distribution of the diversions that are expected to occur as a result of the LSJR alternatives as simulated by the WSE model.

While substantially reducing existing surface water supplies of service providers can be considered an impact, the extent to which service providers are affected is a function of their ability to use existing alternative supplies (e.g., groundwater) or develop alternative water supplies. Therefore, surface water diversion reductions are then compared to service providers' reliance on surface water as characterized in Tables 13-3a and 13-3b. The reductions are considered within the general context of water supply agreements and contracts to qualitatively determine whether service providers may need new and expanded water supply treatment facilities or water supply infrastructure.

This chapter provides a programmatic-level analysis of the impacts on service providers and refers to Chapter 16, *Evaluation of Other Indirect and Additional Actions* (Section 16.2), with respect to environmental impacts caused by service provider actions associated with various potential responses to the alternative. Potential impacts that result from service provider actions associated with the LSJR alternatives depend upon the specific actions selected by the service providers responsible for implementing site-specific projects, most of which are public agencies subject to their own CEQA obligations. Service providers may choose any approach described in Chapter 16, or a combination of approaches, or they may identify another as-yet unknown approach to meet its own unique needs. Potential new water supply facilities or infrastructure are described in Chapter 16 and include but are not limited to substitution of surface water with groundwater, aquifer storage and recovery, and recycled water sources (Sections 16.2.2, 16.2.3, and 16.2.4, respectively).

Changes to SJR inflow into the southern Delta at Vernalis resulting from the LSJR alternatives could change exports to service providers in the export service areas (i.e., CVP and SWP contractors). This is because some of the inflow is exported at the CVP and SWP pumps to the export service areas. The methodology used to estimate exports is fully described in Chapter 5, *Surface Hydrology and Water Quality* and Appendix F.1, *Hydrologic and Water Quality Modeling* (Section F.1.7) and results are presented in Tables F.1.7-2 through F.1.7-5 and summarized in Table 5-21. These changes are used in this chapter to qualitatively discuss whether there would be sufficient water supplies to service providers relying on CVP/SWP exports (Impact SP-3). To estimate the possible effects on exports, analysis related to exports and outflow assumes the State Water Board will not change the export constraints to protect any increased flows downstream of Vernalis because the LSJR alternatives as described in Chapter 3, *Alternatives Description*, would not affect export regulations**.**

Table 13-14. Distribution of Annual Baseline Water Supply and Differences from Baseline (Changes in Diversions) in the Eastside Tributaries for the LSJR Alternatives for 1922–2003

		LSJR Alternative 2				LSJR Alternative 3		LSJR Alternative 4	
		20% Unimpaired Flow		30% Unimpaired Flow					
Percentile	Baseline (TAF)	Change (TAF)	Percent Change	Change (TAF)	Percent Change	Change (TAF)	Percent Change	Change (TAF)	Percent Change
A. Annual Diversions from the Stanislaus River									
Minimum	252	-24	-9	-24	-9	-24	-9	-87	-35
10	538	-86	-16	-218	-41	-273	-51	-337	-63
20	583	-13	-2	-75	-13	-180	-31	-362	-62
30	605	20	3	11	2	-140	-23	-344	-57
40	630	27	4	10	2	-46	-7	-308	-49
50	661	12	2	3	0	-21	-3	-262	-40
60	676	10	2	5	1	-14	-2	-166	-25
70	694	7	1	3	0	-15	-2	-93	-13
80	708	1	0	1	0	-13	-2	-47	-7
90	723	1	0	1	0	-11	-1	-33	-4
Maximum	772	0	0	0	0	-13	-2	-13	-2
Average	637	-12	-2	-33	-5	-79	-12	-206	-32
B. Annual Diversions from the Tuolumne River									
Minimum	557	-186	-33	-186	-33	-216	-39	-343	-62
10	685	-33	-5	-142	-21	-277	-40	-456	-67
20	796	-15	-2	-81	-10	-234	-29	-510	-64
30	828	-6	-1	-51	-6	-188	-23	-450	-54
40	855	-3	0	-32	-4	-92	-11	-395	-46
50	878	-9	-1	-27	-3	-76	-9	-340	-39
60	891	-2	0	-20	-2	-63	-7	-218	-24
70	915	-5	-1	-25	-3	-56	-6	-153	-17
80	932	-2	0	-21	-2	-45	-5	-112	-12
90	960	-3	0	-22	-2	-52	-5	-107	-11

		LSJR Alternative 2				LSJR Alternative 3		LSJR Alternative 4	
		20% Unimpaired Flow		30% Unimpaired Flow					
Percentile	Baseline (TAF)	Change (TAF)	Percent Change	Change (TAF)	Percent Change	Change (TAF)	Percent Change	Change (TAF)	Percent Change
Maximum	1034	0	0	-30	-3	-30	-3	-127	-12
Average	851	-20	-2	-56	-7	-119	-14	-298	-35
C. Annual Diversions from the Merced River									
Minimum	136	67	49	67	49	67	49	66	48
10	441	-60	-14	-133	-30	-181	-41	-221	-50
20	558	-85	-15	-151	-27	-204	-37	-314	-56
30	578	-27	-5	-83	-14	-170	-29	-294	-51
40	602	-37	-6	-65	-11	-135	-22	-279	-46
50	617	-29	-5	-57	-9	-65	-11	-236	-38
60	630	-27	-4	-48	-8	-66	-10	-188	-30
70	643	-24	-4	-32	-5	-60	-9	-149	-23
80	653	-22	-3	-27	-4	-46	-7	-96	-15
90	669	-11	-2	-27	-4	-37	-6	-90	-13
Maximum	680	-7	-1	-7	-1	-7	-1	-32	-5
Average	580	-33	-6	-60	-10	-95	-16	-185	-32

TAF = thousand acre-feet

Groundwater Supply

Results from the WSE model, information from Tables 13-3a and 13-3b, and general information regarding municipal and potable wells were used to estimate the potential impact on groundwater supply for service providers (Impact SP-1). Specifically, the impact analysis draws from the following.

- Chapter 9, *Groundwater Resources*, assessment of Impact GW-1 (if reduction in surface water diversion would substantially deplete groundwater supplies or interfere with recharge).
- Public water suppliers' reliance on groundwater.
- Number of active groundwater wells operated by individual public water suppliers.
- Size of population served by the public water suppliers.
- Depths of selected wells shown in Table 13-3b and depths to groundwater at those wells.

In Chapter 9, it is determined that impacts on groundwater resources would be significant and unavoidable in the Extended Merced Subbasin under LSJR Alternative 2 with adaptive implementation; in the Modesto, Turlock, and Extended Merced Subbasins under LSJR Alternative 3; and in all four subbasins under LSJR Alternative 4. The public water suppliers located in the impacted subbasins (see Tables 13-3a and 13-3b) are more likely to be affected by a reduction in groundwater supply.

Municipal groundwater well depths in the four groundwater subbasins range from 110–1,216 feet (Table 13-3b), whereas domestic well depths range from 48–580 feet (State Water Board 2016b). In general, public wells are deeper than private wells because private entities generally do not have the resources to drill deep. Accordingly, private wells can run dry before public wells do during drought. The difference between well depth and depth to groundwater, as shown in Table 13-3b, is a rough indicator of the potential for a well to run dry in the future—the smaller the difference, the more likely that a particular well may go dry. This is a general indicator given that the depth to water in a well may be different from the depth to groundwater depending on the site-specific hydrogeologic characteristics of the aquifer and well depth. The depth to groundwater (Table 13-3b) refers to depth to the top of the aquifer; yet municipal drinking water wells can draw water from deeper confined aquifers, which can cause water level in a well to be different from the top of the aquifer. However, when the depth to groundwater approaches the well depth, there is more certainty that a well is close to running dry. A difference of 100 feet or less was selected to identify wells considered potentially at risk of running dry sooner relative to other wells (identified in the gray-shaded cells in Table 13-3b). If significant groundwater impacts are allowed to continue for multiple years, especially in combination with drought, these wells may be at greater risk of running dry.

As discussed for surface water supply, this chapter provides a programmatic-level analysis of the impacts on service providers and refers to Chapter 16, *Evaluation of Other Indirect and Additional Actions* (Sections 16.2 and 16.3), with respect to environmental impacts caused by service provider actions associated with various potential responses to the alternative. Potential new water supply facilities or infrastructure are described in Chapter 16 and include substitution of surface water with groundwater, aquifer storage and recovery, and recycled water sources (Sections 16.2.2, 16.2.3, and 16.2.4, respectively). With respect to CCSF, potential new water supply facilities or infrastructure may include in-Delta diversions and water supply desalination (Sections 16.2.5 and 16.2.6, respectively).

Surface Water Quality

The potential impacts of the LSJR alternatives on existing drinking water sources in the southern Delta are evaluated quantitatively using the expected change in inflow from the LSJR predicted by the WSE model and the simulated effects on salinity values in the southern Delta (Impact SP-2a). EC in the southern Delta is largely controlled by EC at Vernalis. Table 13-15 presents baseline EC at Vernalis. The effect of LSJR Alternatives 2, 3, and 4 on these EC values is presented in Tables 13-16, 13-17, and 13-18. These tables show effects of the LSJR alternatives over a range of year types with the wetter, high flow years being represented by the salinity values at the lower ranges of the cumulative distribution and the drier, low flow years being represented by the salinity values at the higher ranges of the cumulative distribution. Further information about Delta salinity and changes in salinity within the southern Delta is presented in detail in Chapter 5, *Surface Hydrology and Water Quality,* in Appendix F.1, *Hydrologic and Water Quality Modeling* (which presents salinity changes under each of the LSJR alternatives) and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta* (which presents historic salinity data).

Table 13-15. Cumulative Distribution of Baseline EC (µmhos/cm) at Vernalis

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Minimum	193	155	222	218	186	193	180	144	205	222	163	227	216
10	440	507	606	386	296	264	245	192	334	451	420	448	422
20	468	542	749	568	344	306	305	299	406	544	442	481	456
30	484	584	784	672	466	337	347	341	432	573	497	495	486
40	489	596	807	752	600	458	374	362	467	586	528	510	517
50	496	612	813	769	684	631	413	375	528	597	547	521	576
60	506	629	824	785	780	658	442	421	564	610	569	539	609
70	515	645	831	798	870	791	517	461	588	629	590	552	633
80	529	664	844	824	936	859	594	567	628	643	613	567	673
90	547	686	867	838	1,000	1,000	676	644	682	660	655	590	730
Maximum	589	759	926	882	1,000	1,000	700	700	700	700	700	669	747
Average	492	598	770	697	655	592	435	407	508	577	535	518	565

Note: 1 dS/m (deciSiemens per meter) = 1,000 µmhos/cm (micromhos per centimeter)

Table 13-16. Change in Cumulative Distribution of EC (µmhos/cm) at Vernalis Associated with LSJR Alternative 2

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Minimum	0	0	0	0	0	0	0	-2	0	0	0	0	0
10	-3	-6	17	-6	-15	-1	-2	-5	-57	0	-8	-21	0
20	-1	-6	6	-23	-9	-5	-5	-30	-89	7	-2	-3	7
30	-4	-4	10	24	24	-7	10	-34	-87	8	1	1	1
40	-2	0	2	2	-27	15	22	-36	-92	1	6	-3	3
50	-4	0	5	8	-32	0	17	-32	-109	4	0	-2	-1
60	-1	0	1	4	73	45	23	-48	-122	9	-1	-3	-14
70	-1	0	1	8	42	46	-20	-54	-124	2	-10	-3	-5
80	0	0	4	1	41	110	-58	-129	-104	6	-6	0	-11
90	-3	0	0	10	0	0	-80	-141	-98	4	0	-5	-45
Maximum	0	0	0	0	0	0	0	0	0	0	0	0	-9
Average	-2	-2	8	3	11	16	-9	-52	-85	4	-4	-6	-10

Note: 1 dS/m (deciSiemens per meter) = 1,000 µmhos/cm (micromhos per centimeter)

Table 13-17. Change in Cumulative Distribution of EC (µmhos/cm) at Vernalis Associated with LSJR Alternative 3

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Minimum	12	0	0	0	0	0	-5	-8	-64	25	0	0	3
10	-85	-99	144	29	-14	23	-29	-24	-150	-24	-3	-87	-9
20	-100	-118	43	106	35	7	-53	-112	-196	-38	-6	-98	-9
30	-80	-74	24	86	-17	37	-61	-139	-190	-2	14	-59	-10
40	-45	-6	6	24	-102	-20	-62	-145	-194	-1	-3	-9	-12
50	-29	0	11	16	30	-90	-74	-140	-229	-9	8	3	-44
60	-32	2	5	14	17	-48	-86	-174	-225	-3	5	2	-55
70	-36	1	10	19	-6	-119	-127	-189	-216	-2	3	-1	-58
80	-41	0	15	9	9	-97	-180	-275	-210	-1	4	0	-72
90	-32	2	27	17	-12	-75	-214	-327	-192	4	0	-5	-111
Maximum	-49	0	74	55	0	0	0	-143	-27	0	0	0	-36
Average	-49	-30	36	36	-6	-38	-94	-163	-185	-8	3	-25	-43

Note: 1 dS/m (deciSiemens per meter) = 1,000 µmhos/cm (micromhos per centimeter)

Table 13-18. Change in Cumulative Distribution of EC (µmhos/cm) at Vernalis Associated with LSJR Alternative 4

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Minimum	12	0	0	17	0	-32	-42	-31	-109	65	45	0	18
10	-93	-106	154	96	-31	2	-71	-62	-206	31	0	-87	-13
20	-103	-129	49	144	-10	-10	-104	-161	-260	23	55	-98	-22
30	-81	-74	24	95	-88	-7	-124	-192	-255	16	12	-59	-22
40	-45	-6	8	28	-185	-77	-138	-207	-262	19	5	-3	-37
50	-27	0	11	22	-109	-200	-156	-209	-305	16	17	5	-72
60	-32	2	7	24	-142	-186	-154	-245	-309	19	8	4	-89
70	-36	1	10	31	-78	-239	-216	-268	-305	9	4	0	-93
80	-41	0	15	24	-100	-250	-263	-364	-325	17	7	-2	-115
90	-27	2	27	34	-50	-243	-306	-411	-336	40	0	-1	-156
Maximum	-49	0	74	118	0	0	-150	-262	-53	0	0	0	-67
Average	-50	-32	41	51	-75	-121	-163	-229	-265	20	12	-22	-69

Note: 1 dS/m (deciSiemens per meter) = 1,000 µmhos/cm (micromhos per centimeter)

The magnitude of the effects of the alternatives at other locations within the southern Delta (e.g., Old River at Tracy Boulevard and SJR at Brandt Bridge) is expected to be slightly larger than the effects at Vernalis. This is because the Vernalis flow, which affects EC at Vernalis, also affects the change in EC between Vernalis and locations within the southern Delta. As a result, if an alternative is expected to cause a reduction in EC at Vernalis, it would be expected to cause a slightly greater reduction farther downstream. Similarly, if an alternative is expected to cause an increase in EC at Vernalis, it would be expected to cause a slightly greater increase farther downstream. This information is used to identify whether the salinity in the southern Delta would result in a substantial degradation to water quality such that municipal drinking water sources could be affected.

Groundwater Quality

The potential impact of the LSJR alternatives on groundwater quality in municipal drinking water wells in the Eastern San Joaquin, Modesto, Turlock, and Extended Merced Subbasins is evaluated qualitatively. The analysis is based, in part, on the discussion of potential indirect impacts on groundwater quality due to increased pumping and subsequent reduction of groundwater level as discussed in Section 13.2.1, *Lower San Joaquin River and Tributaries.* The analysis also considers MCL exceedance information for primary detected contaminants in groundwater wells of selected municipalities in the area of potential effects during a representative non-drought year and drought year (Table 13-5), when groundwater reliance increased. To determine whether drinking water sources could be significantly impacted, these variables are considered together within the context of the California Health and Safety Code provisions of the Safe Drinking Water Act to prevent contaminated water from getting to the end user of a public water system (Impacts SP-2a and SP-2b).

Adaptive Implementation

Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis at all times during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from that which would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, which would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.

4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cubic feet per second (cfs) may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water.

The quantitative results included in the figures, tables, and text of this chapter present WSE modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). However, the modeling does allow some inflows to be retained in the reservoirs after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects and this is included in the results presented in this chapter. If the percent of unimpaired flow is not specified in this chapter, these are the percentages of unimpaired flow evaluated in the impact analysis. However, as part of adaptive implementation method 1, the required percent of unimpaired flow could change by up to 10 percent if the STM Working Group agrees to adjust it. The highest possible percent of unimpaired flow associated with an LSJR alternative is also evaluated in the impact analysis if long-term implementation of method 1 has the potential to affect a determination of significance. For example, if the determination for LSJR Alternative 2 at 20 percent unimpaired flow is less than significant, but the determination for LSJR Alternative 3 at 40 percent unimpaired flow is significant, then LSJR Alternative 2 is also evaluated at the 30 percent unimpaired flow. This use of modeling provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

The potential impacts of the SDWQ alternatives on existing drinking water sources in the southern Delta are evaluated qualitatively. The general range of historical salinity levels in the southern Delta are presented in Chapter 5, *Surface Hydrology and Water Quality* (Tables 5-15a-d), Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, and Section 13.2.3, *Southern Delta*.

The SDWQ alternatives would amend the southern Delta salinity objectives identified in the 2006 Bay-Delta Plan. The 2006 Bay-Delta Plan established salinity objectives to protect agricultural beneficial uses in the southern Delta. Under the CWA, the Central Valley Water Board is required to impose permit effluent limitations to achieve water quality objectives in the Bay-Delta Plan for point-source dischargers where there is a reasonable potential for the discharge to cause or contribute to an excursion above a water quality objective. (40 C.F.R., § 122.44, subd. (d).) The average annual effluent EC data, existing regulatory effluent limitations, and evaluation of enforcement orders are used to qualitatively discuss whether service providers could meet the objectives of the SDWQ alternatives. For this assessment, it is assumed that under baseline conditions, WWTP effluent limitations would be based on the current limitations. With the exception of Deuel, these are less stringent than the southern Delta salinity objectives specified in the 2006 Bay-Delta Plan. If the salinity objectives are changed according to SDWQ Alternatives 2 and 3, WWTP effluent limitations for salinity would have be modified and set equal to the new objectives. The potential impacts of the SDWQ alternatives on WWTPs are evaluated qualitatively (Impact SP-1).

The Central Valley Water Board has determined the discharge from Discovery Bay CSD does not have reasonable potential to cause or contribute to an exceedance of the 2006 Bay-Delta Plan water quality objectives in Old River or the southern Delta (Marshall pers. comm. 2012a). This is because of the large dilution in Old River and the good quality of water in Old River coming down from the Sacramento River (Marshall pers. comm. 2012a). Thus, Discovery Bay CSD can comply with the water quality objectives and does not need effluent limits based on the 2006 Bay-Delta Plan water quality objectives (Marshall pers. comm. 2012a). Since SDWQ Alternatives 2 and 3 are higher than the existing salinity water quality objectives, Discovery Bay CSD would likely continue to not have a reasonable potential to cause or contribute to exceedance of the proposed salinity water quality objectives such that effluent limitations would not be required. Therefore, Discovery Bay CSD is not included in the analysis in Section 13.4.3, *Impacts and Mitigation Measures*.

This chapter provides a programmatic-level analysis of the impacts on service providers and refers to Chapter 16, *Evaluation of Other Indirect and Additional Actions* (Section 16.4), with respect to environmental impacts caused by service provider actions associated with various methods of compliance. Service providers may choose any method of compliance described in Chapter 16, or a combination of methods, or they may identify another as-yet unknown method of compliance to comply with requirements from the revised objectives. Potential new water supply facilities or infrastructure are described in Chapter 16 and include the following: new source water supplies including new and expanded infrastructure to support such supplies; salinity pretreatment programs; desalination, including new and expanded salinity removal facilities at existing WWTPs; and the real-time management of agricultural return flow, including the use of detention ponds (Sections 16.4.2, 16.4.3, 16.4.4, respectively).[23]

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[23] The City of Tracy finalized and adopted the *Initial Study/Mitigated Negative Declaration for the Tracy Desalinization and Green Energy Project* in April of 2012 (City of Tracy 2011b, 2012). Impact determinations from this document are incorporated herein. This document identified available and feasible mitigation necessary to reduce potentially significant environmental effects on aesthetics, agriculture, air quality, biological resources,

As noted in Chapter 9, *Groundwater Resources*, and discussed in Appendix B, *State Water Board's Environmental Checklist,* the SDWQ alternatives would not result in a change in the minimal groundwater pumping that currently takes place in the southern Delta; therefore, with regard to groundwater supply, and associated effects on drinking water supply, the SDWQ alternatives are not addressed in this chapter.

13.4.3 Impacts and Mitigation Measures

Impact SP-1: Require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2 (Less than significant/Significant and unavoidable with adaptive implementation)

Surface Water Supply

Results of the WSE model indicate that service providers diverting surface water from the Stanislaus, Tuolumne, and Merced Rivers would generally be able to divert similar surface water amounts at similar times under LSJR Alternative 2 when compared to baseline (Table 5-19). For LSJR Alternative 2, the average percent reduction in water supply on the Stanislaus, Tuolumne, and Merced Rivers was estimated to be 2 percent, 2 percent, and 6 percent, respectively (Table 13-14). Service providers relying on surface water diversions are expected to receive similar surface water supplies relative to baseline conditions. Because it is expected these service providers would have sufficient sources of surface water, it is not expected they would need to construct new or expanded water treatment facilities or water supply infrastructure.

Groundwater Supply

As described in Chapter 9, *Groundwater Resources*, the slight reduction in recharge compared to baseline, due to small changes to average surface water diversions under LSJR Alternative 2, would not likely result in a substantial reduction in groundwater levels. As such, those service providers (Tables 13-3a and 13-3b) and private users that rely primarily on groundwater would have sufficient sources for municipal and domestic uses under LSJR Alternative 2 and, therefore, it is not

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cultural resources, geology and soils, hydrology and water quality, hazards and hazardous materials, and land use and planning. With the implementation of mitigation measures, impacts on these resources were determined by the City to be reduced to a less-than-significant level.

expected they would need to construct new or expand existing water treatment facilities or water supply infrastructure. Impacts would be less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June time frame. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent.

Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. WSE model results show that under LSJR Alternative 2 the 1,200-cfs February–June base flow requirement at Vernalis would require a flow augmentation in the three eastside tributaries and LSJR only 2.7 percent of the time in the 82-year record analyzed. Similarly, flow augmentation would be required 0.7 percent of the time to meet a 1,000 cfs requirement and 0.5 percent of the time for an 800 cfs Vernalis base flow requirement. These results indicate that changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR.

Surface Water Supply

At 30 percent unimpaired flow under LSJR Alternative 2 with adaptive implementation method 1, the average percent reduction in water supply on the Stanislaus, Tuolumne, and Merced Rivers was estimated to be 5 percent, 7 percent, and 10 percent, respectively. Thus, surface water supply reductions would be greater at the 30 percent unimpaired flow level compared to 20 percent unimpaired flow. Reductions would be greatest for service providers receiving Merced River diversions (i.e., Merced ID), but would also be substantial for Tuolumne River service providers (i.e., TID, MID, and CCSF).

The extent to which service providers' surface water supplies would actually be reduced is a function of the mechanisms by which they receive the water (e.g., water rights or contracts), existing policies, regulations, and the type of water use they supply. Some water supply contracts have provisions that dictate when and how much surface water other water users receive from irrigation districts. For example, contracts could require the irrigation district to supply the full contracted amount of surface water to the other water user at all times, including during drought or water restricted periods. Some irrigation districts have policies in place that may require curtailment of water supplies during periods of surface water reduction (Table 13-13). Although California recognizes water for domestic purposes as the most important use of water and irrigation as the next most important use (Cal. Code Regs., tit. 23, § 106), this does not necessarily mean that the water supply for domestic uses cannot be modified. Furthermore, if other water districts that supply domestic uses are receiving water through contracts with irrigation districts, then these uses would not necessarily be protected. For example, if MID experiences water shortages, its deliveries to service providers serving urban uses (e.g., City of Modesto) could be cut back proportionally, as described in MID's various plans and policy documents.

The extent to which service providers that primarily rely on surface water are affected by a reduction in surface water diversions is a function of their ability to develop alternative water supplies or rely on their current existing alternative supplies (e.g., groundwater). Service providers that rely heavily or primarily on surface water diversions to supply water to their service areas could experience significant reductions in water supply, depending on the various factors described above (i.e., mechanism by which they receive the water, existing policies, regulations, and the type of water use they supply). Thus, the extent of the effect under LSJR Alternative 2 with adaptive implementation method 1 would be great when compared to baseline. MID, TID, and Merced ID currently rely on surface water diversions from the Tuolumne and Merced Rivers as their primary water supply. The City of Modesto currently relies on surface water diversions to meet nearly 40 percent of its water demand (Table 13-3b). If surface water diversions were reduced on the Tuolumne and Merced Rivers, (depending on the mechanism by which they receive the water, existing policies, regulations, and the type of water use they supply) these service providers would likely be greatly affected. The LSJR Alternative 2 program of implementation states that the State Water Board will take actions as necessary to ensure implementation of flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods. Actions may include assistance with funding and development of water conservation efforts and regional water supply reliability projects and regulating public drinking water systems and water rights. These actions would be aimed at those service providers supplying water to municipal users and may offset water supply reduction impacts on providers. However, it is expected service providers may need to construct or expand new water treatment facilities or water supply infrastructure to try to accommodate reductions in surface water supplies. Additionally, as a result of reduced water supply, LSJR Alternative 2 with adaptive implementation method 1 may necessitate WWTPs and related infrastructure to be modified to allow or augment water recycling or meet pretreatment or NPDES permit requirements.

As discussed in Appendix L, *City and County of San Francisco Analyses*, some portion of the increased release flows from New Don Pedro Reservoir on the Tuolumne River could be shared by CCSF (especially during a prolonged drought), thus potentially reducing water supply. This would depend on a number of factors, including the assignment of responsibility to CCSF or the irrigation districts to meet the flow requirements through a proceeding amending water rights or through FERC relicensing, the interpretation of the Fourth Agreement, whether CCSF pays the irrigation districts to release water to meet the flow requirement, and any future agreement between the irrigation districts and CCSF. If a prolonged drought occurred, and CCSF was required to share in the release of flows, thus potentially reducing water supply, it may need to construct new and expanded water treatment supply infrastructure for in-Delta diversion and desalination to accommodate reductions in surface water supplies, as identified in Chapter 16, *Evaluation of Other Indirect and Additional Actions,* Sections 16.2.5 and 16.2.6, respectively.

Identifying the exact nature of the new and expanded facilities potentially needed by those irrigation districts and other water suppliers to replace potentially reduced surface water supplies is speculative (as discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*). However, it is reasonably foreseeable that new and expanded facilities could include the following.

- New and expanded infrastructure, if needed, to convey water obtained through water transfers or sales from other entities or watershed.[24]
- New and expanded groundwater well(s) and distribution infrastructure (e.g., underground pipes) and infrastructure to treat groundwater, if needed.
- New and expanded conjunctive groundwater use program(s), which could use available capacity in unlined canals and agricultural fields that are not in production to recharge groundwater basins during high flow events.
- New and expanded facilities at existing WWTPs and distribution infrastructure (e.g., underground pipes) to increase the supply of recycled water as a possible source of water.
- New surface water reservoir and distribution infrastructure.

Depending on the location and particular construction and operational requirements, construction of the new and modified facilities described above could result in physical environmental impacts on resources such as those listed below (Chapter 16, Section 16.2.1, Section 16.2.2 and Table 16-7; Section 16.2.3 and Table 16-9; Section 16.2.4 and Table 16-10; and Section 16.2.7 and Table 16-11b).

- Air quality and greenhouse gases, as a result of emissions generated by construction equipment and construction trips.
- Biological resources, as a result of potential dust, noise, or possible removal of special-status species and habitat.
- Cultural resources, as a result of excavation, grading, and other soil-disturbing activities, if construction takes place in an area moderately or highly sensitive for cultural resources.
- Geology, as a result of potential erosion or construction on unstable soils.
- Water quality, as a result of runoff associated with dust control or other construction activities, or as a result of potential construction material spills, such as of lubricants or fuel.
- Hazards, as a result of handling, use, and disposal of hazardous materials during construction.
- Mineral resources, as a result of potentially inhibiting access to known mineral resources.

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[24] One of the options that the service providers have to compensate for the reduction of surface water and groundwater availability due to the LSJR alternatives is water purchase or transfer from other entities. As discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, Section 16.2.1, it is not expected that additional infrastructure would be needed. If new and expanded infrastructure is needed, the physical environmental impacts of the construction would be similar to those discussed in Chapter 16, Section 16.2.2 and Table 16-7; Section 16.2.3 and Table 16-9; and Section 16.2.4 and Table 16-10).

- Noise, as a result of the use of construction equipment within proximity to potential sensitive receptors (e.g., residences).
- Traffic, as a result of the use of construction equipment and commuting of construction workers.

Depending on the location and particular construction and operational requirements, operation of new and modified facilities could result in physical environmental impacts on resources such as those listed below (Chapter 16, Section 16.2.1, Section 16.2.2, and Table 16-7; Section 16.2.3 and Table 16-9; Section 16.2.4 and Table 16-10; and Section 16.2.7 and Table 16-11b).

- Aesthetics, as a result of operational lighting or blocking of views if views are designated and present and sensitive receptors are present.
- Air quality and greenhouse gases, as a result of increased energy demand.
- Biological resources, as a result of potential water quality impacts related to treating new water source(s).
- Water quality, as a result of the need to treat new water source(s).
- Hazards, as a result of handling materials (e.g., chlorine) potentially needed to treat new water source(s).
- Mineral resources, as a result of potentially inhibiting access to known mineral resources.
- Noise, as a result of new equipment operating within proximity to potential sensitive receptors (e.g., residences).

Should service providers need to construct new and expanded water treatment facilities or water supply infrastructure as a result of implementation of method 1 under LSJR Alternative 2, the activities involved therein are anticipated to either be discretionary actions and/or meet the definition of a project for CEQA. (State CEQA Guidelines, §§ 15377–15378.) If the activities are not discretionary actions and/or do not meet the definition of a project under CEQA (e.g., private well construction or modification), then it is presumed there would be very limited environmental impacts such that they would not rise to the level of causing potentially significant environmental impacts necessitating environmental documentation (e.g., mitigated negative declaration, environmental impact report). The decision-making body of the lead agency (e.g., public water supplier or local agency) would approve discretionary action(s) associated with any new or modified facilities or infrastructure. The approval of new or modified facilities would require the preparation and approval of a CEQA document identifying project-specific details and specific resource analyses of potentially significant impacts. The CEQA document would disclose any project-specific, potentially significant environmental impacts resulting from new or modified facilities. As part of this process, the decision-making body would be responsible (not the State Water Board) for imposing mitigation measures or BMPs if project-specific environmental impacts deemed potentially significant.

Although the exact scope and scale of environmental impacts cannot be determined because identifying the exact nature of the new and expanded facilities is speculative, Table 16-38 in Chapter 16 lists possible mitigation measures that would likely reduce potentially significant impacts on environmental resources as a result of construction and operation of new or modified facilities or infrastructure. For example, potentially significant environmental impacts due to construction may be mitigated through design, timing, and construction BMPs. Infrastructure could be designed to have minimal impact on the surrounding environment (e.g., pipelines could be buried under existing roads). Construction-timing mitigation measures may include scheduling such that work in surface waters, if needed, takes place after aquatic species have migrated out of the area. BMPs for construction activities could include the use of erosion prevention practices near surface waters, for example.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) CEQA does not grant agencies new, discretionary powers independent of the powers granted to the agencies by other laws. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040.) Accordingly, a mitigation measure may be legally infeasible if the lead agency does not have the authority to require or implement it. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040.) Since the State Water Board would not be responsible for or have discretionary authority to approve the construction of any new or modified facilities or infrastructure, it is not feasible for the State Water Board to impose the possible mitigation measures listed in Table 16-38. Moreover, the State Water Boards lacks authority to impose mitigation measures related to impacts on certain resources (e.g., air, noise or traffic). Agencies responsible for approving the project-specific new or modified facilities can and should impose the applicable mitigation measures in Table 16-38. The storage capacities for the reservoirs are fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions as mitigation under LSJR Alternative 2. More water released to the rivers would leave less water for surface water diversions. Therefore, there is no feasible mitigation the State Water Board can implement to reduce environmental impacts resulting from the need for new or modified facilities or infrastructure. Impacts would be significant and unavoidable.

Groundwater Supply

MID, TID and Merced ID may need to supplement their surface water supplies with groundwater to meet their needs, under adaptive implementation method 1, as described above and in Chapter 9, *Groundwater Resources*. Impacts on groundwater would increase relative to the 20 percent unimpaired flow level in the Extended Merced Subbasin depending on the use by Merced ID. As described in Chapter 9, LSJR Alternative 2 adaptive implementation method 1 would result in a substantial depletion of groundwater supplies in the Extended Merced Subbasin if implemented on a long-term basis. Were that to occur, service providers and private users relying heavily or primarily on groundwater sources for municipal and domestic use could experience significant reductions in water supply over the long term. The magnitude or severity of the effect would depend on additional factors such as the size of the population being served and the number of active municipal wells in their service area, and the range of differences between well depths and depths to groundwater (Table 13-3b), and other factors (e.g., physical condition of wells). For example, Le Grand CSD serves a population of 1,700 with three active wells (Table 13-3b), and the range of difference between well depths and depths to groundwater for those three wells is 91–536 feet. In light of these three factors, the demand for municipal and domestic water supply in the service area of Le Grand CSD with implementation of LSJR Alternative 2 with adaptive implementation method 1 could likely be met in the short term. But the district's wells are aging, and two have experienced age-related failures recently (Chauhan pers. comm.). If groundwater reductions were to continue for multiple years, especially in combination with drought conditions, these wells may be at risk of running dry.

Similar to the above discussion related to surface water supply, over the long term, service providers in the Extended Merced Subbasin may need to construct new and expanded water treatment facilities or water supply infrastructure (e.g., additional wells) to meet demands. Additionally, as a result of reduced water supply, implementation of LSJR Alternative 2 with adaptive implementation method 1 may necessitate WWTPs and related infrastructure to be modified to allow or augment water recycling or meet pretreatment or NPDES permit requirements. Therefore, impacts would be significant. Drinking water sourced from domestic wells would be affected similarly, and it is assumed that those affected would need to find an alternative drinking water supply such as bottled water or drill additional groundwater wells, and impacts would be significant.

Similar to the reductions in surface water supply, the reduction in groundwater supply to service providers in the Extended Merced Subbasin identified in Table 13-3a would likely require these entities to construct new and expanded water treatment facilities or water supply infrastructure (e.g., additional wells) to replace groundwater supplies. Identifying the exact nature of the new and expanded facilities needed to replace potentially reduced surface water diversions and groundwater supplies is speculative (as discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*). However, it is reasonably foreseeable that the facilities could include the following.

- New and expanded infrastructure, if needed, to convey water obtained through water transfers or sales from other entities.
- New and expanded groundwater well(s) and distribution infrastructure (e.g., underground pipes) and infrastructure to treat groundwater, if needed.
- New and expanded conjunctive groundwater use program(s), which could use available capacity in unlined canals and agricultural fields that are not in production to recharge groundwater basins during high flow events.
- New and expanded facilities at existing WWTPs and distribution infrastructure (e.g., underground pipes) to increase the supply of recycled water as a possible source of water.

Similar to the above discussion related to surface water supply, identifying the exact nature of the new and expanded facilities potentially needed to replace potentially reduced groundwater supplies is speculative (as discussed in Chapter 16). Depending on the location and particular construction and operational requirements, construction of the new or modified facilities, as described above, could result in significant physical environmental impacts on resources (Chapter 16 Section 16.2.1; Section 16.2.2 and Table 16-7; Section 16.2.3 and Table 16-9; and Section 16.2.4 and Table 16-10). Although the exact scope and scale of environmental impacts cannot be determined because identifying the exact nature of the new and expanded facilities is speculative, Table 16-38 in Chapter 16 lists possible mitigation measures that would likely reduce potentially significant impacts on environmental resources as a result of construction and operation of new or modified facilities or infrastructure. Because the State Water Board would not be responsible for or have discretionary authority to approve the construction of any new or modified facilities or infrastructure, it is not feasible for the State Water Board to implement the possible mitigation measures listed in Table 16-38. Moreover, the State Water Board lacks authority to impose mitigation measures related to impacts such as air and noise. Agencies responsible for approving the project-specific new or modified facilities can and should impose the mitigation measures. The storage capacities for the reservoirs are fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions as mitigation under LSJR Alternative 2 with adaptive implementation method 1. More water released to the Merced River would leave less water for surface water diversions. Therefore, there is no feasible mitigation the State Water Board can implement to reduce environmental impacts on service providers and domestic groundwater users resulting from the need for new or modified facilities or infrastructure. Impacts would be significant and unavoidable.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Surface Water Supply

As a result of LSJR Alternative 3, WSE model results predict surface water diversions would be generally reduced when compared to baseline conditions on the Stanislaus, Tuolumne, and Merced Rivers (Table 5-19). The average percent reduction in water supply on the Stanislaus, Tuolumne, and Merced Rivers was estimated to be 12 percent, 14 percent, and 16 percent, respectively, for LSJR Alternative 3 (Table 13-14). The impacts of LSJR Alternative 3 would be similar to those described above for LSJR Alternative 2 with adaptive implementation method 1; however, more irrigation districts and other water suppliers would likely be impacted as surface water supplies would be significantly reduced on the Stanislaus, Tuolumne, and Merced Rivers. Those irrigation districts and other water suppliers on the Tuolumne and Merced Rivers would be affected as described above for LSJR Alternative 2 with adaptive implementation method 1 (i.e., MID, TID, and Merced ID, City of Modesto and CCSF[25]). Additionally, it is expected that SSJID, OID, the City of Tracy, and SEWD may also be affected under LSJR Alternative 3, given the predicted reductions in surface water supplies and because they rely heavily or primarily on surface water to meet demand.

The reductions in surface water supply to service providers would likely require these entities to construct new and expanded water treatment facilities or water supply infrastructure to replace reduced surface water supplies. Identifying the exact nature of the new and expanded facilities needed to replace potentially reduced surface water diversions is speculative (as discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*). Because the surface water diversions on the Stanislaus, Tuolumne, and Merced Rivers would be reduced, potentially requiring the construction of new and expanded water treatment facilities or water supply infrastructure, impacts would be significant.

Similar to the discussion of surface water supply impacts under LSJR Alternative 2 with adaptive implementation method 1, identifying the exact nature of the new and expanded facilities potentially needed by service providers and domestic groundwater users to replace potentially reduced groundwater supplies is speculative (as discussed in Chapter 16). Depending on location and particular construction and operational requirements, construction of the new or modified facilities, as described above, could result in significant physical environmental impacts on environmental resources (Chapter 16, Section 16.2.2 and Table 16-7; Section 16.2.3 and Table 16-9; and Section 16.2.4 and Table 16-10). Although the exact scope and scale of environmental impacts cannot be determined because identifying the exact nature of the new and expanded facilities is speculative, Table 16-38 in Chapter 16 lists possible mitigation measures that would likely reduce potentially significant impacts on environmental resources as a result of construction and operation

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[25] With respect to CCSF and similar to the discussion under LSJR Alternative 2, with adaptive implementation method 1, and as discussed in Appendix L, *City and County of San Francisco Analyses*, a potential reduction in water supply during a prolonged drought would depend on a number of factors, including the assignment of responsibility to CCSF or the irrigation districts to meet the flow requirements through a proceeding amending water rights or through FERC relicensing, the interpretation of the Fourth Agreement, whether CCSF pays the irrigation districts to release water to meet the flow requirement, and any future agreement between the irrigation districts and CCSF. If a prolonged drought occurred, and CCSF was required to share in the release of flows, thus potentially reducing water supply, it may need to construct new and expanded water treatment supply infrastructure to accommodate reductions in surface water supplies.

of new or modified facilities or infrastructure. Because the State Water Board would not be responsible for or have discretionary authority to approve the construction of any new or modified facilities or infrastructure, it is not feasible for the State Water Board to impose the possible mitigation measures listed in Table 16-38. Moreover, the State Water Board lacks authority to impose mitigation measures related to impacts such as air and noise. Agencies responsible for approving the project-specific new or modified facilities can and should impose the applicable mitigation measures in Table 16-38. The storage capacities for the reservoirs are fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions as mitigation under LSJR Alternative 3. More water released to the river would leave less water for surface water diversions. Therefore, there is no feasible mitigation the State Water Board can implement to reduce environmental impacts resulting from the need for new or modified facilities or infrastructure. Impacts would be significant and unavoidable.

Groundwater Supply

The average annual groundwater balance is expected to be substantially reduced in the Modesto, Turlock, and Extended Merced Subbasins under LSJR Alternative 3, which would eventually produce a measureable decrease in groundwater elevations (Chapter 9, *Groundwater Resources*). This effect would be more severe in dry years and in areas farther from the LSJR, the valley low point toward which groundwater moves. These substantial reductions in groundwater supplies would, in turn, impact service providers (Tables 13-3a and 13-3b) and private groundwater users in these subbasins who are relying heavily or primarily on groundwater sources for municipal and domestic uses. These entities would likely experience significant reductions in their groundwater supply, particularly over the long term and in dry years. As discussed under LSJR Alternative 2 with adaptive implementation method 1, the magnitude or severity of the effect would depend on additional factors, such as the size of the population being served, the number of active municipal wells in their service area, the range of differences between well depths and depths to groundwater (Table 13-3b), and other factors (e.g., physical condition of wells). Service providers at particular risk include those that have a higher potential for a well to run dry in the future. For example, Hickman, Hilmar CWD, Hughson, and Keys CSD in the Turlock Subbasin; Le Grand CSD and the City of Merced in the Extended Merced Subbasin; and the City of Modesto in the Modesto Subbasin (Table 13-3b). This is because these service providers have relatively few active wells relative to the size of the population served and/or the range of difference between well depths and depths to groundwater is less than 100 feet (Table 13-3b). Private groundwater users are also at risk because domestic wells are typically more shallow and older than public municipal wells. Impacts would be significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on surface water diversions or groundwater supplies. Adaptive implementation method 3 would result in a shift in the volume of February–June water available to other parts of the year and would be unlikely to affect surface water diversions or groundwater supplies because the total amount of water available for diversion would be unaffected. Adaptive implementation method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40 percent minimum unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K, *Revised Water Quality Control Plan*. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 2 with adaptive implementation method 1 or LSJR Alternative 4 with adaptive implementation method 1, respectively. Reducing the unimpaired flow percentage from 40 percent to 30 percent would reduce impacts on several service providers, and effects may be limited to MID, TID, CCSF, and Merced ID, and those service providers (Tables 13-3a and 13-3b) and private groundwater users that rely solely on the Extended Merced Subbasin for water supply. However, increasing the unimpaired flow percentage from 40 percent to 50 percent would increase the magnitude and severity of the impacts on those service providers at 40 percent unimpaired flow because there would be less surface water available at 50 percent unimpaired flow. In addition, the Eastern San Joaquin Basin could be affected. As such, impacts would be significant. As discussed under LSJR Alternative 2 with adaptive implementation method 1, there is no feasible State Water Board mitigation to reduce these impacts, and impacts would be significant and unavoidable. Agencies responsible for approving the project-specific new or modified facilities can and should impose the applicable mitigation measures in Table 16-38.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Surface Water Supply

As a result of LSJR Alternative 4, WSE model results predict surface water diversions would be greatly reduced when compared to baseline conditions on all three eastside tributaries. The average percent reduction in water supply on the Stanislaus, Tuolumne, and Merced Rivers was estimated to be 32 percent, 35 percent, and 32 percent, respectively, for LSJR Alternative 4 (Table 13-14). As discussed above under LSJR Alternative 3, the extent to which service providers' surface water supplies could be reduced is a function of the mechanism by which they receive the water (e.g., water rights, contracts), existing policies and regulations, and the type of water use they supply. The extent to which service providers are affected by a reduction in surface water diversions is a function of their abilities to use existing alternative supplies (e.g., groundwater) or develop alternative water supplies. Service providers that currently use surface water as a significant source of water supply could experience reductions in surface water supplies (e.g., irrigation districts, Tracy, SEWD, Modesto, CCSF[26]) similar to impacts described above for LSJR Alternative 3 with and without adaptive implementation. LSJR Alternative 4 program of implementation describes actions to assure that implementation does not impact supplies of water for minimum health and safety

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[26] With respect to CCSF, and similar to the discussion under LSJR Alternative 2 with adaptive implementation method 1, and as discussed in Appendix L, *City and County of San Francisco Analyses*, a potential reduction in water supply during a prolonged drought would depend on a number of factors, including the assignment of responsibility to CCSF or the irrigation districts to meet the flow requirements through a proceeding amending water rights or through FERC relicensing, the interpretation of the Fourth Agreement, whether CCSF pays the irrigation districts to release water to meet the flow requirement, and any future agreement between the irrigation districts and CCSF. If a prolonged drought occurred, and CCSF was required to share in the release of flows, thus potentially reducing water supply, it may need to construct new and expanded water treatment supply infrastructure to accommodate reductions in surface water supplies.

needs, and these actions may offset water supply reduction impacts on service providers for municipal uses. However, impacts would be significant.

The reductions in surface water supply to service providers would likely require these providers to construct new and expanded water treatment facilities or water supply infrastructure to replace reduced surface water supplies. Additionally, as a result of reduced water supply, LSJR Alternative 4 may necessitate WWTPs and related infrastructure to be modified to allow or augment water recycling or meet pretreatment or NPDES permit requirements. Identifying the exact nature of the new and expanded facilities needed to replace potentially reduced surface water diversions is speculative (as discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*). Because the surface water diversions on the Stanislaus, Tuolumne, and Merced Rivers would be reduced, potentially requiring the construction of new and expanded water treatment facilities or water supply infrastructure, impacts would be significant.

Similar to the discussion of surface water supply impacts under LSJR Alternative 2, with adaptive implementation method 1, identifying the exact nature of the new and expanded facilities potentially needed by public and private water suppliers to replace potentially reduced municipal groundwater supplies is speculative (as discussed in Chapter 16). Depending on the location and the particular construction and operational requirements, construction of the new or modified facilities, as described above, could result in significant physical environmental impacts on environmental resources (Chapter 16, Section 16.2.2 and Table 16-7; Section 16.2.3 and Table 16-9; and Section 16.2.4 and Table 16-10). Although the exact scope and scale of environmental impacts cannot be determined because identifying the exact nature of the new and expanded facilities is speculative, Table 16-38 in Chapter 16 lists possible mitigation measures that would likely reduce potentially significant impacts on environmental resources as a result of construction and operation of new or modified facilities or infrastructure. Because the State Water Board would not be responsible for or have discretionary authority to approve the construction of any new or modified facilities or infrastructure, it is not feasible for the State Water Board to impose the possible mitigation measures listed in Table 16-38. Moreover, the State Water Boards lacks authority to impose mitigation measures related to impacts such as air and noise. Agencies responsible for approving the project-specific new or modified facilities can and should impose the applicable mitigation measures in Table 16-38. The current storage capacities for the reservoirs are fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions as a means of mitigation under LSJR Alternative 4 with adaptive implementation. More water released to the river would leave less water for surface water diversions. Therefore, there is no feasible mitigation the State Water Board can implement to reduce environmental impacts resulting from the need for new or modified facilities or infrastructure. Therefore, impacts under LSJR Alternative 4, with adaptive implementation, would be significant and unavoidable.

Groundwater Supply

The average annual groundwater balance is expected to be substantially reduced under LSJR Alternative 4, with or without adaptive implementation, in the Eastern San Joaquin, Modesto, Turlock, and Extended Merced Subbasins (Chapter 9, *Groundwater Resources*). This would eventually produce a measureable decrease in groundwater elevations. This affect would be more severe in dry years and in areas farther from the SJR, the valley low point toward which groundwater moves. These substantial reductions in groundwater supplies would in turn impact service providers (Tables 13-3a and 13-3b) and private groundwater users in these subbasins that are relying heavily or primarily on groundwater sources for municipal and domestic needs. These entities would likely experience significant reductions in groundwater supply, particularly over the long term and in dry years. As discussed under LSJR Alternative 2, with adaptive implementation method 1, the magnitude or severity of the effect would depend on additional factors such as the size of the population being served, the number of active municipal wells in their service area, the range of differences between well depths and depths to groundwater (Table 13-3b), and other factors (e.g., physical condition of wells). Service providers and private groundwater users at particular risk include those that have a higher potential for a well to run dry in the future, including those identified under LSJR Alternative 3, with adaptive implementation. In addition, service providers in the Eastern San Joaquin Subbasin that may be more likely to be affected include Escalon and Lathrop (Table 13-3b). This is because these service providers have relatively few active wells relative to the size of the population served and/or the range of difference between well depths and depths to groundwater is less than 100 feet (Table 13-3b). Impacts would be significant and unavoidable.

SDWQ Alternative 2 (Significant and unavoidable)

The historical range of salinity in the southern Delta would be maintained under SDWQ Alternative 2 (Section 13.2.3, *Southern Delta*, and Impact SP-2a). Therefore, it is not anticipated that service providers supplying drinking water from the southern Delta would need to construct or modify water treatment facilities or water supply infrastructure because of increased salinity.

Under SDWQ Alternative 2, the Vernalis and southern Delta salinity objectives would be changed to a year-round value of 1.0 dS/m. However, EC at Vernalis would be maintained at or below 0.7 dS/m April–August and 1.0 dS/m September–March through requirements in USBR's water rights permits as provided for in the program of implementation. This would provide some assimilative capacity downstream of Vernalis and protect beneficial agricultural uses. Of the six WWTPs discussed herein, two have made efforts or are working toward reducing salinity concentrations in their source water supplies, four are implementing pretreatment programs to reduce water softener use among water users, and three are either proposing to construct or are already operating a RO treatment system. Table 13-11 summarizes the salinity reduction efforts of the various WWTPs. These activities would be expected to reduce the salinity in the treated effluent discharged into the southern Delta by the service providers. Fixing existing RO systems or upgrading existing facilities would be expected to reduce salts more, when compared to other efforts such as educational programs or salt pretreatment programs. However, the total effect of these various projects to the southern Delta water quality depends on many variables, such as the type of activity, salt content of the source water, and operating efficiency of the activity.

The average annual EC values for WWTPs in the past few years were generally very close to or just over 1.0 dS/m. Table 13-19 identifies the average EC for each WWTP and their potential ability to comply with a potential 1.0 dS/m effluent limitation based on the violations documented to date and annual average EC data.

Manteca would be expected to comply with a 1.0 dS/m effluent limitation because their average annual EC values are currently near or below 1.0 dS/m, and they have not had any violations in the past. Because it is anticipated that this WWTP would not exceed wastewater treatment requirements, it is not likely to need additional facilities. Impacts would be less than significant.

Table 13-19. Southern Delta Wastewater Treatment Plant 2011-2014 Annual Average EC Effluent Data and Potential to Comply with an Effluent Limitation set to the SDWQ Alternative 2 EC Objective (dS/m [µmhos/cm])

WWTP Facility	2011 Annual Average EC Effluent	2012 Annual Average EC Effluent	2013Annual Average EC Effluent	2014 Annual Average EC Effluent	2015 Annual Average EC Effluent	Potential to Comply with an Effluent Limitation Set to the SDWQ Alternative 2 (1 dS/m) Objective? (Y/N)
Tracy	1.2 [1,171]	1.2 [1,229]	1.2 [1,250]	1.3 [1,342]	1.2 [1,246]	N
Deuel	2.4 [2,415][a]	1.4 [1,410]	1.3 [1,280]	1.3 [1,275]	2.2 [2,254]	N
Manteca	0.8 [781]	0.8 [778]	0.7 [750]	0.7 [745]	0.8 [800]	Y
Stockton	1.0 [1,032]	1.0 [958]	1.0 [973]	1.0 [982]	1.1 [1,127]	N
Mountain House CSD	0.7 [693]	0.9 [908]	1.0 [990]	1.0 [991]	1.0 [1,029]	N

Sources: See Table 13-8 for sources and additional information.

EC = electrical conductivity (salinity)

WWTP = Wastewater treatment plant

dS/m = deciSiemens per meter. Conversion is 1 dS/m = 1000 µmhos/cm. Numbers presented in dS/m were rounded.

µmhos/cm =micromhos per centimeter

CIWQS = California Integrated Water Quality System

CSD = Community Services District

[a] No data on CIWQS, so the comparison to potential effluent limitations is based on recent ACLC R5-2011-0575, which reported an average monthly EC value of 2,260 µmhos/cm on January 31, 2011 and 2,570 µmhos/cm on February 28, 2011.

Deuel currently has an NPDES permit with an EC standard based on the 2006 Bay-Delta plan EC objective. It has previously violated the permit standards. The past and current violations are potentially attributed to a malfunction of the RO and brine concentrator systems used by the facility to reduce the salinity of the groundwater supply. SDWQ Alternative 2 would not change the permit standards for Deuel and thus would not increase the number of existing violations, increase the salinity of the discharge at Deuel, or change the existing RO and brine concentrator facilities. Therefore, Deuel could potentially continue to have exceedances of the permit requirements and continue to violate their permit under SDWQ Alternative 2. Therefore, a change in baseline conditions is not expected with respect to Deuel. Impacts would be less than significant.

Mountain House CSD, Stockton, and Tracy currently have annual EC averages equal to or greater than 1.0 dS/m; therefore, they could have some exceedances of the wastewater treatment requirements if an effluent limitation is set at 1.0 dS/m. However, these exceedances would only potentially result in an exceedance of the salinity objective (i.e., 1.0 dS/m) for the southern Delta for half of the year (between the months of September and March), when salinity at Vernalis may be as high as 1.0 dS/m, which would provide no assimilative capacity. Mountain House CSD, Stockton, and Tracy may exceed an effluent limitation set at the water quality objective proposed under SDWQ Alternative 2 and this could require modifications to their wastewater treatment plants. For Tracy, these modifications could exceed those expected under their Desalinization and Green Energy Project. The Mountain House CSD and the Cities of Stockton and Tracy may apply for a variance under the Central Valley Water Board's Variance Policy discussed above once it is approved by USEPA. Under the policy, Mountain House CSD and Stockton and Tracy could be granted a variance from meeting the water quality-based effluent limitations for salinity constituents for a period of up to ten years. If the variance is not authorized, or if it is and after the expiration of the variance, Mountain House CSD and Stockton and Tracy still cannot meet the effluent limitations for salinity based on SDWQ 2, it is reasonably foreseeable that modifications to their facilities could occur. It is anticipated modifications could include the following (Chapter 16, *Evaluation of Other Indirect and Additional Actions*, Section 16.4.1, 16.4.2 and 16.4.3).

- New and expanded infrastructure to support new source water supplies, which could include canals, underground pipelines, and obtaining water transfers from one location to another to supply the new source water.
- New and expanded salinity pretreatment programs relying on industrial facility pretreatment or residential program(s), which could include modifications to existing industrial facilities such that waste is treated prior to discharge in the sewer system or a residential program educating people to remove water softeners.
- New and expanded salinity removal facilities at existing WWTPs (e.g., RO), which could include modifications to existing wastewater treatment plants such that salinity is removed from the treated effluent prior to discharge.

Depending on the type of facility, location, and particular operational requirements, construction of the facilities described above could result in physical environmental impacts on resources such as those listed below (Chapter 16, Section 16.4.1 and Table 16-25; Section 16.4.2 and Table 16-28; and Section 16.4.3 and Table 16-30).

- Air quality and greenhouse gases, as a result of construction equipment emissions and construction trips.

- Biological resources, as a result of dust, noise, or possible removal of sensitive biological species if present.
- Cultural resources, as a result of excavation, grading, and other soil disturbing activities, if construction takes place in a moderately or highly sensitive area for cultural resources.
- Geologic resources, as a result of erosion or constructing in unstable soils.
- Hazards, as a result of handling hazardous material during construction such as lubricants or diesel.
- Water quality, as a result of potentially generating runoff associated with dust control or other construction activities.
- Noise, as a result of the use of construction equipment if sensitive receptors (e.g., residences) are located within close proximity of the WWTP.
- Traffic, as a result of the use of construction equipment and commuting construction workers.

Depending on the type of facility, location, and particular operational requirements, operation of new or modified facilities could result in physical environmental impacts on resources such as those listed below (Chapter 16, Section 16.4.1 and Table 16-25; Section 16.4.2 and Table 16-28; and Section 16.4.3 and Table 16-30).

- Aesthetics, as a result of operational lighting.
- Air quality and greenhouse gases, as a result of operational emissions associated with salt removal techniques.
- Hazardous materials, as a result of an increase in hazardous materials on site associated with salt removal techniques.
- Noise, as a result of new equipment operating within proximity to sensitive receptors (e.g., residences).
- Traffic, as a result of an increase in employees to operate the new equipment or equipment modifications.

Therefore, since WWTPs may not be able to meet a new NPDES effluent limitation based on SDWQ Alternative 2, the construction and operation of new or modified wastewater treatment facilities or infrastructure is expected and impacts would be significant.

New or modified wastewater treatment facilities or infrastructure would be under the jurisdiction of the service providers performing the action or the jurisdiction of the local agency in which the new or modified facility or infrastructure is proposed. The activities described above (e.g., new and expanded facilities at WWTPs) are anticipated to either be discretionary actions and/or meet the definition of a project for CEQA. (State CEQA Guidelines, §§ 15377–15378.) If they are not discretionary actions and/or do not meet the definition of a project under CEQA, then it is presumed there would be very limited environmental impacts such that they would not rise to the level of causing potentially significant environmental impacts necessitating environmental documentation (e.g., mitigated negative declaration, environmental impact report). As part of this process, the decision-making body (e.g., board of the service provider or municipality) would impose mitigation measures or BMPs if project-specific environmental impacts were deemed potentially significant. Although the exact scope and scale, and extent of potentially significant environmental impacts cannot be determined, Table 16-38 in Chapter 16 identifies mitigation measures that would likely reduce potentially significant impacts on environmental resources as a result of construction and operation of new or modified facilities or infrastructure. For example, potentially significant environmental impacts due to construction may be mitigated through design, timing, and construction BMPs. Facilities could be designed to have minimal impact on the surrounding environment (e.g., pipelines could be buried under existing roads). Construction-timing mitigation measures may include scheduling such that work in surface waters, if needed, would take place after aquatic species have migrated out of the area. BMPs for construction activities could include the use of straw bales to prevent erosion near surface waters.

The State Water Board does not have the authority to approve the construction of any of the new or modified facilities or infrastructure. Accordingly, it is not feasible for the State Water Board to impose mitigation measures related to the construction of new and modified facilities to reduce potentially significant environmental impacts. Moreover, the State Water Board lacks authority to impose mitigation measures related to impacts on certain resources (e.g., air, noise, or traffic). Lead agencies can and should impose the mitigation measures in Table 16-38 when approving construction of these facilities. Until and unless that occurs, impacts would remain significant and unavoidable.

With respect to the operation of any new or modified facility or infrastructure, the Central Valley Water Board issues NPDES permits for the WWTPs that impose discharge requirements to implement requirements of the Clean Water Act and applicable water quality control plans. None of the mitigation measures in Table 16-38 for the operation of any new or modified facility or infrastructure is a measure the Central Valley Water Board has authority to impose in NPDES permits. Lead agencies can and should impose the mitigation measures in Table 16-38 when approving the operation of these facilities. Until and unless that occurs, impacts would remain significant and unavoidable.

SDWQ Alternative 3 (Less than significant)

The historical range of salinity in the southern Delta would be maintained under SDWQ Alternative 3 (Section 13.2.3, *Southern Delta*, and Impact SP-2a). Therefore, it is not anticipated that service providers supplying drinking water from the southern Delta would need to construct or modify water treatment facilities or water supply infrastructure because of increases in salinity.

Table 13-20 identifies the average EC for each WWTP and each one's potential ability to comply with SDWQ Alternative 3 without new or modified facilities, based on past violation information and 2011–2014 EC data.

All of the service providers would be expected to be able to comply with SDWQ Alternative 3 without new or modified facilities based on annual average EC data and previous EC violations. Deuel currently has EC averages that are below the SDWQ Alternative 3 objectives, but has had past EC violations. As discussed above under SDWQ Alternative 2, the past violations are potentially attributed to a malfunction of the RO and brine concentrator systems used by the facility to reduce the salinity of the groundwater supply. Because no additional service providers are expected to require modifications or new facilities, impacts would be less than significant.

Table 13-20. Current Southern Delta Wastewater Treatment Plant 2011–2014 Annual Average EC Effluent Data and Potential to Comply with an Effluent Limitation set to the SDWQ Alternative 3 EC Objective (dS/m [µmhos/cm])

WWTP Facility	2011 Annual Average EC Effluent	2012 Annual Average EC Effluent	2013 Annual Average EC Effluent	2014 Annual Average EC Effluent	2015 Annual Average EC Effluent	Potential to Comply with an Effluent Limitation Set to the SDWQ Alternative 3 (1.4 dS/m) Objective? (Y/N)
Tracy	1.2 [1,1171]	1.2 [1,229]	1.2 [1,250]	1.3 [1,342]	1.2 [1,246]	Y
Deuel	2.4 [2,415][a]	1.4 [1,410]	1.3 [1,280]	1.3 [1,275]	2.2 [2,254]	N
Manteca	0.8 [781]	0.8 [778]	0.7 [750]	0.7 [745]	0.8 [800]	Y
Stockton	1.0 [1,032]	1.0 [958]	1.0 [973]	1.0 [982]	1.1 [1,127]	Y
Mountain House CSD	0.7 [693]	0.9 [908	1.0 [990]	1.0 [991]	1.0 [1,029]	Y

See Table 13-8 for sources and additional information.

EC = electrical conductivity (salinity)

WWTP = Wastewater treatment plant

dS/m = deciSiemens per meter. Conversion is 1 dS/m = 1000 µmhos/cm. Numbers presented in dS/m were rounded.

µmhos/cm = micromhos per centimeter

CIWQS = California Integrated Water Quality System

CSD = Community Services District

[a] No data on CIWQS, so the comparison to potential effluent limitations is based on recent ACLC R5-2011-0575, which reported an average monthly EC value of 2,260 µmhos/cm on January 31, 2011 and 2,570 µmhos/cm on February 28, 2011.

Impact SP-2a: Violate any water quality standards such that drinking water quality from public water systems would be affected

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Groundwater Subbasins

There would likely be no degradation of groundwater quality under LSJR Alternative 2 because substantial additional pumping is not expected and, thus, the direction of groundwater flow would not change such that any localized groundwater contamination that exists in the subbasins would be affected (as described in Chapter 9, *Groundwater Resources*). Accordingly, LSJR Alternative 2 would have a less-than-significant impact on the quality of water for public water systems.

Southern Delta

Salinity is a concern for service providers (e.g., CCWD) diverting drinking water from the southern Delta. Because drinking water effects associated with salinity are considered to be related to taste and not harmful to human health, secondary drinking water MCLs are established for EC as summarized in Section 13.2.3, *Southern Delta*. As discussed in Chapter 5, *Surface Hydrology and Water Quality*, the WSE model predicts that average inflows from the LSJR would generally increase (Tables 5-16 and 5-17d), which is expected to lead to a slight decrease in average salinity in the southern Delta (Table 13-16). At Vernalis, any increases in EC would generally be very small and occur during July and December–March. Relatively large decreases in EC are predicted to occur during May and June. Overall, under LSJR Alternative 2, salinity in the southern Delta is not expected to differ much from baseline salinity and would decrease on average. In addition, generally a large portion of drinking water originates from the Sacramento River due to the locations of some drinking water intakes in the Delta (e.g., western Delta); as such, changes in SJR flow are unlikely to modify flows on the Sacramento River such that exceedances in drinking water standards would result. Therefore, LSJR Alternative 2 is not expected to substantially degrade water quality, specifically with respect to salinity, and service providers diverting water for domestic purposes would not be affected by the quality of water in the southern Delta under this alternative. Impacts would be less than significant.

Higher Delta inflow from the LSJR helps improve other water quality constituents besides salinity. For example, higher inflow (and outflow) helps to limit seawater intrusion, which brings salinity and bromide into the Delta, and it helps dilute water quality components that are generated within the Delta, such as organic carbon. Organic carbon also enters the Delta in the tributary water. Rainfall runoff events would continue to bring organic carbon from the tributaries into the Delta under the LSJR Alternative 2 in a manner similar to baseline conditions. However, releases from large reservoirs tend to have relatively low organic carbon, so higher releases from New Melones Reservoir, New Don Pedro Reservoir, and Lake McClure would not cause an increase in organic carbon. Releases from the eastside reservoirs and inflow to the southern Delta would generally be similar to baseline conditions (although slightly higher on average) under LSJR Alternative 2; therefore, the effect of the alternative on water quality constituents besides salinity would also be less than significant.

Adaptive Implementation

Groundwater

As discussed under Impact SP-1, LSJR Alternative 2 with adaptive implementation could result in substantial groundwater depletions from increased pumping within the Extended Merced Subbasin. This could affect the direction of groundwater flow, and localized groundwater contamination could move in undesirable directions as explained in Section 13.2.1, *Lower San Joaquin River and Tributaries*, potentially affecting groundwater as a source of drinking water. The change in groundwater flow is dependent on the location of pumping, the amount of groundwater pumped and the frequency at which pumping occurs, and hydrogeological characteristics of the aquifer (e.g., consolidated clays with low permeability or unconsolidated sands with high permeability). As discussed previously, the impact of groundwater pumping on groundwater quality also depends on a number of different variables, including location and depth of the well, the amount and frequency of groundwater pumping, number and proximity of nearby wells, hydrogeological characteristics of the aquifer, distance between the well(s) and the contaminant(s), contaminant characteristics (e.g., highly mobile in water or adhering primarily to soil), and land use near the well. In addition, it is not possible to predict how the affected parties would respond to the reduction of surface water due to the LSJR alternatives. They may deepen existing wells or build new wells. If they build new wells, it is impossible to determine the number of new wells and their location. Thus, while groundwater pumping can affect groundwater flow and quality, for all of the foregoing reasons, it is speculative to specifically determine what that change in groundwater flow, and its impact on groundwater quality, would be from increased groundwater pumping.

If LSJR Alternative 2, with adaptive implementation, is implemented frequently and long term, it is expected that service providers relying on surface water supplies may need to find alternative supplies (e.g., groundwater), especially those service providers relying on the Merced and Tuolumne Rivers for surface water supplies (i.e., MID, TID and Merced ID, City of Modesto [Table 13-2]). Furthermore, those service providers (Tables 13-3a and 13-3b) relying on the Extended Merced Subbasin for groundwater supply to meet their water needs potentially could be affected by changes in groundwater quality from the migration of contaminants. However, a substantial increase in groundwater pumping would not necessarily result in the use of drinking water that violates water quality standards for several reasons, as described below.

1. During the recent drought, the amount of groundwater pumped for drinking purposes and the service providers' reliance on groundwater greatly increased, and yet there was not a greater number of MCL violations as compared to a wet year based on the CCRs prepared by the service providers (Table 13-5).
2. While drinking water quality standard exceedances have been detected at the wellhead in different locations in the area of potential effects, these exceedances reflect raw, untreated groundwater quality. Service providers are required take actions to ensure that the water is in compliance with relevant drinking water standards before it is served to the public. Such actions

include monitoring groundwater quality regularly, and if any exceedances are detected, bringing the well offline until the problem is rectified (see Section 13.3.2, *State [Regulatory Background]*). Treatment options include blending, large-scale treatment systems, wellhead treatment systems, or Point-of-Use (POU)/Point-of-Entry (POE) systems used in homes or residences. These types of treatment options are currently used by service providers if and when a water quality concern is identified. Potential environmental impacts resulting from these types of new and expanded facilities are addressed under Impact SP-1.

3. While increased groundwater pumping may expedite the migration of contaminants introduced at the land surface, such as nitrate from fertilizer application on crop lands, into the water table and flow towards the well, the effect would be localized (i.e., at the well; see Section 13.2.1, *Lower San Joaquin River and Tributaries*). Hence, it would be unlikely that such contamination would spread to other parts of the aquifer.

Therefore, under LSJR Alternative 2, with adaptive implementation, it is not expected that the quality of groundwater used in public water systems would be affected such that violations of water quality standards would occur. Accordingly, impacts would be less than significant.

While mitigation is not required for less-than-significant impacts, local agencies can and should nevertheless exercise their authorities under SGMA to prevent and/or mitigate any degradation of groundwater quality from the migration of contaminants. As explained in Section 9.3.2 of Chapter 9, *Groundwater Resources*, under SGMA,[27] local agencies in high- and medium-priority basins are required to form groundwater sustainability agencies by June 30, 2017, that will develop and implement GSPs that achieve sustainable groundwater management within 20 years. Sustainable groundwater management includes not causing chronic lowering of groundwater levels and significant and unreasonable degradation of water quality, including the migration of contaminant plumes that impair water supplies. GSPs must be adopted by January 31, 2020, for the Extended Merced Subbasin (as well as the Eastern San Joaquin and Chowchilla Subbasins). GSPs for the Modesto and Turlock Subbasins must be adopted by January 31, 2022). Upon GSP adoption, SGMA grants the local GSA specific authorities to manage and protect its groundwater basin including, but not limited to, the ability to require reporting of groundwater withdrawals and to control groundwater extractions by regulating, limiting, or suspending extractions from wells. If a local agency is unwilling or unable to manage its groundwater resources to prevent undesirable results as defined under the SGMA, which include chronic lowering of groundwater levels or migration of contamination, then SGMA empowers the state to provide interim management until local agencies are able to assume management. Thus, under SGMA, local agencies can and should manage groundwater subbasins both in terms of over-pumping and groundwater quality degradation from migrating contaminants.

Southern Delta

LSJR Alternative 2, with adaptive implementation method 1, would result in overall higher flows into the southern Delta. Higher Delta inflow from the LSJR helps improve water quality constituents, including salinity. For example, higher inflow (and outflow) helps to limit seawater intrusion, which brings salinity and bromide into the Delta, and it helps dilute water quality components that are generated within the Delta, such as organic carbon. Adaptive implementation method 2 would not

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[27] The State Water Board is required to consider the policies of SGMA when revising or adopting policies, regulations, or criteria. (Wat. Code, § 10720.9.)

authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Adaptive implementation method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June minimum flow requirement. WSE model results indicate that changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR. As such, releases from the eastside reservoirs and inflow to the southern Delta would generally be higher on average under LSJR Alternative 2, with adaptive implementation methods 1, 2, and 4; therefore, the effect of the alternative on surface water quality constituents including salinity is expected to be less than significant.

LSJR Alternatives 3 and 4 (Less than significant/Less than significant with adaptive implementation)

Groundwater Subbasins

Reductions in groundwater levels in the Modesto, Turlock, and Extended Merced Subbasins and also the Eastern San Joaquin Subbasin under LSJR Alternatives 3 and 4with or without adaptive implementation, could occur as a result of increased pumping. This could affect the direction of groundwater flow, and localized groundwater contamination could move in undesirable directions as explained in Section 13.2.1, *Lower San Joaquin River and Tributaries*, potentially affecting groundwater as a source of drinking water. As discussed previously, the impact of groundwater pumping on groundwater quality depends on a number of different variables, including location and depth of the well, the amount and frequency of groundwater pumping, number and proximity of nearby wells, hydrogeological characteristics of the aquifer (e.g., consolidated clays with low permeability or unconsolidated sands with high permeability), distance between the well(s) and the contaminant(s), contaminant characteristics (e.g., highly mobile in water or adhering primarily to soil), and land use near the well. In addition, it is not possible to predict how the affected parties would respond to the reduction of surface water due to the LSJR alternatives. The affected parties may deepen existing wells or build new wells. If they build new wells, it is impossible to determine the number of wells and their location. Thus while groundwater pumping can affect groundwater flow and quality, for all of the foregoing reasons, it is speculative to specifically determine what that change in groundwater flow and its impact on groundwater quality would be from to increased groundwater pumping.

If LSJR Alternatives 3 or 4, with or without adaptive implementation, is implemented, it is expected that service providers relying on surface water supplies may need to find alternative supplies (e.g., groundwater). Furthermore, those service providers relying on the Modesto, Turlock, and Extended Merced Subbasins for groundwater supply under LSJR Alternatives 3 and 4 (in addition the Eastern San Joaquin Subbasin under LSJR Alternative 4) to meet their water needs (Table 13-3a), potentially could be affected by changes in groundwater quality from the migration of contaminants. The potential reduction in groundwater quality under Alternatives 3 and 4, with or without adaptive implementation, could degrade drinking water quality for those service providers relying entirely, or in large part, on groundwater for municipal supply (see Tables 13-3a and 3-3b). However, as described for LSJR Alternative 2, a substantial increase in groundwater pumping would not necessarily result in the use of drinking water that violates water quality standards for several reasons as described below.

1. During the recent drought, the amount of groundwater pumped for drinking purpose and the service providers' reliance on groundwater greatly increased and yet there was not a greater number of MCL violations as compared to a wet year based on the CCRs prepared by the service providers (Table 13-5).
2. While drinking water quality standard exceedances have been detected at the wellhead in different locations in the area of potential effects, these exceedances reflect raw, untreated groundwater quality. Service providers are required take actions to ensure that the water is in compliance with relevant drinking water standards before it is served to the public. Such actions include monitoring groundwater quality regularly, and if any exceedances are detected, bringing the well offline until the problem is rectified (see Section 13.3.2*, State [Regulatory Background]*. Treatment options include blending, large-scale treatment systems, wellhead treatment systems, or POU/POE systems used in homes or residences. These types of treatment options are currently used by service providers if and when a water quality concern is identified. Potential environmental impacts resulting from these types of new and expanded facilities are addressed under Impact SP-1.
3. While increased groundwater pumping may expedite the migration of contaminants introduced at the land surface, such as nitrate from fertilizer application on crop lands, into the water table and flow towards the well, the effect would be localized, i.e., at the well (see Section 13.2.1, *Lower San Joaquin River and Tributaries*). Hence, it would be unlikely that such contamination would spread to other parts of the aquifer.

Therefore, under LSJR Alternatives 3 and 4, with or without adaptive implementation, it is not expected that the quality of groundwater used for public water systems would be affected such that violations of water quality standards would occur. Accordingly, impacts would be less than significant.

While mitigation measures are not required for less-than-significant impacts, local agencies can and should nevertheless exercise their authorities under SGMA to prevent and/or mitigate any degradation of groundwater quality from the migration of contaminants. As explained in Section 9.3.2 of Chapter 9, *Groundwater Resources*, under SGMA, local agencies in high- and medium-priority basins are required to form groundwater sustainability agencies by June 30, 2017, that will develop and implement GSPs that achieve sustainable groundwater management within 20 years. Sustainable groundwater management includes not causing chronic lowering of groundwater levels and significant and unreasonable degradation of water quality, including the migration of contaminant plumes that impair water supplies. GSPs must be adopted by January 31, 2020, for Eastern San Joaquin, Merced and Chowchilla Subbasins. GSPs for Modesto and Turlock Subbasins must be adopted by January 31, 2022. Upon GSP adoption, SGMA grants the local GSA specific authorities to manage and protect its groundwater basin including, but not limited to, the ability to require reporting of groundwater withdrawals and to control groundwater extractions by regulating, limiting, or suspending extractions from wells. If a local agency is unwilling or unable to manage its groundwater resources to prevent undesirable results as defined under the SGMA, which include but are not limited to chronic lowering of groundwater levels or migration of contamination, then SGMA empowers the state to provide interim management until local agencies are able to assume management. Thus, under SGMA, local agencies can and should manage their groundwater subbasins both in terms of over-pumping and groundwater quality degradation from migrating contaminants.

Southern Delta

Inflows from the LSJR to the southern Delta are expected to generally increase February–June and have relatively small changes the rest of the year. Additional water into the southern Delta under LSJR Alternative 3 or LSJR Alternative 4, is not expected to substantially degrade the existing water quality of the southern Delta. Some months may experience small increases in salinity, but these increases would be the most noticeable during periods of high flow when Vernalis EC is relative low and would not cause drinking water problems (primarily within the minimum to 40th percentile of the cumulative distribution for December, January, July, and August [Tables 13-16 and 13-17]). In general, southern Delta salinity would be expected to decrease with LSJR Alternatives 3 and 4, particularly during March through June for both alternatives, as well as during February for LSJR Alternative 4 (Tables 13-16 and 13-17).

Similar to LSJR Alternative 2, LSJR Alternatives 3 and 4 with adaptive implementation methods 1 and 2 would result in overall higher flows into the southern Delta. Higher Delta inflow from the LSJR helps improve other water quality constituents, including salinity. For example, higher inflow (and outflow) helps to limit seawater intrusion, which brings salinity and bromide into the Delta, and it helps dilute water quality components that are generated within the Delta, such as organic carbon. In addition, adaptive implementation method 3 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June minimum flow requirement. WSE model results indicate that changes due to adaptive implementation method 4 under LSJR Alternatives 3 and 4 would rarely alter the flows in the three eastside tributaries or the LSJR. As such, releases from the eastside reservoirs and inflow to the southern Delta would generally be higher on average under LSJR Alternatives 3 and 4, with adaptive implementation methods 1, 2, 3, and 4, when compared to baseline.

Additional inflow would provide additional assimilative capacity to receiving waters for constituents (e.g., salinity) and in general reduce the salinity and other water quality constituents in the southern Delta (Chapter 5, *Surface Hydrology and Water Quality*, Tables 5-29a–c). Therefore, LSJR Alternatives 3 and 4 with or without adaptive implementation are not expected to substantially degrade water quality, and service providers diverting water for municipal purposes from the southern Delta would not be impacted by the quality of water in the southern Delta. Impacts would be less than significant.

SDWQ Alternative 2 (Less than significant)

Salinity is a concern for service providers diverting drinking water from the southern Delta. Because drinking water effects associated with salinity are considered to be related to taste and not harmful to human health, secondary drinking water MCLs are established for EC as summarized in Section 13.3.2. As identified in Section 13.2.3, *Southern Delta*, baseline salinity in the southern Delta is between 0.2 dS/m and 1.2 dS/m during all months of the year, and the salinity at Vernalis has a strong relationship with the salinity of the southern Delta. Under SDWQ 2, the program of implementation would maintain EC at Vernalis at or below 0.7 dS/m April-August and 1.0 dS/m September-March, similar to current conditions, through actions undertaken by USBR in accordance with its water rights. Thus, it is expected the southern Delta would experience salinity levels similar to or better than (see Chapter 5, *Surface Hydrology and Water Quality*, which shows EC exceedances declining under the alternatives) baseline conditions (i.e., 0.2 dS/m–1.2 dS/m). Salinity in the southern Delta would remain below the upper limit for the secondary drinking water MCL (1.6

dS/m) and would still occasionally be above the recommended lower limit for the secondary drinking water MCL (0.9 dS/m). Therefore, SDWQ Alternative 2 is not expected to degrade water quality, and service providers diverting water for domestic purposes would not be impacted by the quality of water in the southern Delta under this alternative. Impacts would be less than significant.

SDWQ Alternative 3 (Less than significant)

Impacts would generally be the same as those discussed under SDWQ Alternative 2. Under SDWQ 3, the program of implementation would maintain EC at Vernalis at or below 0.7 dS/m April–August and 1.0 dS/m September–March, similar to current conditions, through actions undertaken by USBR in accordance with its water rights. This would maintain the historical range of salinity in the southern Delta (i.e., 0.2 dS/m–1.2 dS/m). Salinity in the southern Delta would remain below the upper limit for the secondary drinking water MCL (1.6 dS/m) and would still occasionally be above the recommended lower limit for the secondary drinking water MCL (0.9 dS/m). Salinity levels would not exceed the short term MCL (2.2 dS/m). Therefore, SDWQ Alternative 3 is not expected to degrade water quality and violate standards, and service providers diverting water for domestic purposes would not be impacted by the quality of water in the southern Delta under this alternative. Impacts would be less than significant.

Impact SP-2b: Violate any water quality standards such that drinking water quality from domestic wells would be affected

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2 (Less than significant/ Significant and unavoidable with adaptive implementation)

Groundwater Subbasins

As discussed in SP-2a, there would likely be no degradation of groundwater quality under LSJR Alternative 2 because substantial additional pumping is not expected to occur in the subbasins (as described in Chapter 9, *Groundwater Resources*). Accordingly, LSJR Alternative 2 would have a less-than-significant impact on the quality of water in domestic wells.

Southern Delta

LSJR Alternative 2, would result in overall higher flows into the southern Delta. Higher Delta inflow from the LSJR helps improve water quality constituents, including salinity. Therefore, the effect of the alternative on surface water quality constituents, including salinity, is expected to be less than significant.

Adaptive Implementation

Groundwater

As discussed under Impact SP-1, LSJR Alternative 2 with adaptive implementation could result in substantial groundwater depletions from increased pumping within the Extended Merced Subbasin. This could affect the direction of groundwater flow, and localized groundwater contamination could move in undesirable directions as explained in Section 13.2.1, *Lower San Joaquin River and Tributaries*, potentially affecting groundwater as a source for drinking water. The change in groundwater flow is dependent on the location of pumping, the amount of groundwater pumped and the frequency at which pumping occurs, and hydrogeological characteristics of the aquifer (e.g., consolidated clays with low permeability or unconsolidated sands with high permeability). As discussed previously, the impact of groundwater pumping on groundwater quality also depends on a number of different variables including, but not limited to, location and depth of the well, the amount and frequency of groundwater pumping, number and proximity of nearby wells, hydrogeological characteristics of the aquifer, distance between the well(s) and the contaminant(s), contaminant characteristics (e.g., highly mobile in water or adhering primarily to soil), and land use near the well. In addition, it is not possible to predict how the affected parties would respond to the reduction of surface water due to the LSJR alternatives. They may deepen existing wells or build new wells. If they build new wells, it is impossible to determine the number of new wells and their location. Thus while groundwater pumping can affect groundwater flow and quality, for all of the foregoing reasons, it is speculative to specifically determine what that change in groundwater flow and its impact on groundwater quality would be from the increased groundwater pumping.

If LSJR Alternative 2, with adaptive implementation, is implemented frequently and long term, it is expected that service providers relying on surface water supplies may need to find alternative supplies (e.g., groundwater), especially those service providers relying on the Merced and Tuolumne Rivers for surface water supplies (i.e., MID, TID and Merced ID, City of Modesto [Table 13-2]). Furthermore, those service providers relying on the Extended Merced Subbasin for groundwater supply to meet their water needs (Tables 13-3a and 13 3b) potentially could be affected by changes in groundwater quality from the migration of contaminants.

In contrast to drinking water served by public water systems, a substantial increase in groundwater pumping may result in the use of drinking water by private domestic wells that does not meet water quality standards due to the potential for changes to groundwater quality from the migration of contaminants in the Extended Merced Subbasin. While it is true that pumping greatly increased during the drought and yet there was not a greater number of MCL violations as compared to a wet year as reported by service providers, there is a lack of information to support that this was also the case for private domestic wells. Importantly, private domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. Therefore, there is no required mechanism to prevent private domestic wells from using groundwater that may exceed MCLs.

Therefore, under LSJR Alternative 2 with adaptive implementation there is a potential for the quality of groundwater used in private domestic wells to be affected such that violations of water quality standards would occur. Accordingly, impacts would be significant.

The State Water Board does not have authority to require implementation of mitigation that could reduce this impact to a less-than-significant level, because it does not regulate private domestic wells. It can and does assist in identifying water quality threats through the GAMA Program, which is the State Water Board's comprehensive groundwater quality monitoring program for California, and GeoTracker GAMA, which provides water quality data in California via the internet. Using the data collected in GAMA since year 2000, DDW also provides an online, map-based, tool called "Is My Property Near a Nitrate-Impacted Water Well?" for the domestic owners to evaluate the risk of their well to nitrate contamination. The map-based tool displays well locations of recent nitrate contamination above the MCL within a 2,000 feet radius of an address that the user provides. The tool can be accessed at http://www.waterboards.ca.gov/water_issues/programs/nitrate_project/nitrate_tool/.

Possible mitigation measures owners and operators of private domestic wells should undertake to avoid or reduce potential drinking water impacts at private domestic wells include the following.

- Having a licensed contractor construct wells in accordance with well construction standards.
- Choosing a location for a well to make sure it is free of potential sources of contamination.
- Testing well water at certified drinking water laboratories to ensure its quality.
- If necessary, installing a water treatment system tailored to the overall water chemistry and constituents that need to be removed. Example systems include activated alumina filters, activated charcoal filters, air stripping, anion exchange, and ultraviolet radiation.
- If necessary, drilling a new well that taps into a cleaner aquifer or finding an alternative water source.
- Properly destroying unused and abandoned wells to prevent contamination.

In addition, local agencies can and should exercise their police powers and groundwater management authority under SGMA, described above, to address groundwater contamination so as to prevent and/or mitigate drinking water impacts on private domestic wells. Specifically, under SGMA, local agencies in high- and medium-priority basins are to form GSAs by June 30, 2017, which will develop and implement GSPs that achieve sustainable groundwater management within 20 years. Sustainable groundwater management is defined as "the management and use of groundwater in a manner that can be maintained during the [50 year] planning and implementation horizon without causing undesirable results." (Wat. Code, § 10721, subd. (v).) "Undesirable results" includes "significant and unreasonable degraded water quality, including the migration of contaminant plums that impair water supplies." (Wat. Code, § 10721, subd. (x)(4).) GSPs must be developed for critically overdrafted high- and medium-priority basins by January 31, 2020 (DWR 2016). In the area of potential effects, this deadline applies to the Eastern San Joaquin, Merced, and Chowchilla Subbasins. All other high- or medium-priority basins must adopt GSPs by January 31, 2022. In the study area, this includes Modesto and Turlock Subbasins.

Each GSP must also include measureable objectives as well as milestones in increments of 5 years, to achieve the sustainability goal in the basin within 20 years of the implementation of the plan. (Wat. Code, § 10727.2.)

If local agencies are unwilling or unable to manage their groundwater resources, SGMA authorizes the State Water Board to step in to protect a groundwater basin in limited circumstances: (1) if no agency has opted by the June 30, 2017 to serve as a GSA for a basin, (2) when a GSA does not complete a GSP by the relevant deadline (2020 or 2022), or (3) when the GSP is inadequate or the GSP is not being implemented in a manner that is likely to achieve the plan's sustainability goal(s), and the basin is either in a condition of long-term overdraft or, after January 31, 2025, the State

Water Board determines that the basin is in a condition where groundwater extractions result in significant depletions of interconnected surface waters.

Thus, at this time, local agencies are vested with the mandatory duty to achieve sustainable groundwater management, which includes preventing significant and unreasonable degradation to water quality. These agencies, therefore, can and should exercise their full authorities to address degradation of groundwater quality, both under SGMA and their police powers. Doing so would prevent and/or mitigate private domestic well drinking water supply impacts. Due to inherent uncertainty in the degree to which this mitigation and those listed above may be implemented by local agencies and owners and operators of private domestic wells, drinking water impacts on private domestic wells would remain significant and unavoidable.

Southern Delta

As discussed in Impact SP-2a, LSJR Alternative 2, with adaptive implementation (including method 1), would result in overall higher flows into the southern Delta. Higher Delta inflow from the LSJR helps improve water quality constituents, including salinity. Therefore, the effect of the alternative on surface water quality constituents including salinity is expected to be less than significant.

LSJR Alternatives 3 and 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

Groundwater Subbasins

Reductions in groundwater levels in the Modesto, Turlock, and Extended Merced Subbasins and also the Eastern San Joaquin Subbasin under LSJR Alternatives 3 and 4 with or without adaptive implementation could occur as a result of increased pumping. This could affect the direction of groundwater flow, and localized groundwater contamination could move in undesirable directions as explained in Section 13.2.1, *Lower San Joaquin River and Tributaries*, potentially affecting groundwater as a source for drinking water. The change in groundwater flow is dependent on the location of pumping, the amount of groundwater pumped and the frequency at which pumping occurs, and hydrogeological characteristics of the aquifer (e.g., consolidated clays with low permeability or unconsolidated sands with high permeability). As discussed previously, the impact of groundwater pumping on groundwater quality also depends on a number of different variables, including location and depth of the well, the amount and frequency of groundwater pumping, number and proximity of nearby wells, hydrogeological characteristics of the aquifer, distance between the well(s) and the contaminant(s), contaminant characteristics (e.g., highly mobile in water or adhering primarily to soil), and land use near the well. In addition, it is not possible to predict how the affected parties would respond to the reduction of surface water due to the LSJR alternatives. They may deepen existing wells or build new wells. If they build new wells, it is impossible to determine the number of new wells and their location. Thus while groundwater pumping can affect groundwater flow and quality, for all of the foregoing reasons, it is speculative to specifically determine what that change in groundwater flow and its impact on groundwater quality would be from the increased groundwater pumping.

In contrast to drinking water served by public water systems, a substantial increase in groundwater pumping may result in the use of drinking water by private domestic wells that does not meet water quality standards due to the potential for changes in groundwater quality from the migration of contaminants in the Modesto, Turlock and Extended Merced Subbasins and also the Eastern San Joaquin Subbasin under LSJR Alternatives 3 and 4 with or without adaptive implementation. While it is true that pumping greatly increased during the drought and yet there was not a greater number of MCL violations as compared to a wet year as reported by service providers, there is a lack of information to support that this was also the case for private domestic wells. Importantly, private domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. Therefore, there is no required mechanism to prevent private domestic wells from using groundwater that may exceed MCLs.

Therefore, under LSJR Alternatives 3 and 4, with or without adaptive implementation, there is a potential for the quality of groundwater used in private domestic wells to be affected such that violations of water quality standards would occur. Accordingly, impacts would be significant.

The State Water Board does not have authority to impose mitigation that could reduce this impact to a less-than-significant level, because it does not regulate private domestic wells. It can and does assist in identifying water quality threats through the GAMA Program and GeoTracker GAMA. Using the data collected in GAMA since year 2000, DDW also provides the online, map-based, tool called “Is My Property Near a Nitrate-Impacted Water Well?” for the domestic owners to evaluate the risk of their well to nitrate contamination, described previously under Impact SP-2b, LSJR Alternative 2.

Possible mitigation measures owners and operators of private domestic wells should undertake to avoid or reduce potential drinking water impacts at private domestic wells include the following.

- Having a licensed contractor construct wells in accordance with well construction standards.
- Choosing a location for a well to make sure it is free of potential sources of contamination.
- Testing well water at certified drinking water laboratories to ensure its quality.
- If necessary, installing a water treatment system tailored to the overall water chemistry and constituents that need to be removed. Example systems include activated alumina filters, activated charcoal filters, air stripping, anion exchange, and ultraviolet radiation.
- If necessary, drilling a new well that taps into a cleaner aquifer or finding an alternative water source.
- Properly destroying unused and abandoned wells to prevent contamination.

In addition, local agencies can and should exercise their police powers and groundwater management authority under SGMA, described above, to address groundwater contamination so as to prevent and/or mitigate drinking water impacts on private domestic wells. Specifically, under SGMA, local agencies in high- and medium-priority basins are to form GSAs by June 30, 2017, which will develop and implement GSPs that achieve sustainable groundwater management within 20 years. Sustainable groundwater management is defined as “the management and use of groundwater in a manner that can be maintained during the [50 year] planning and implementation horizon without causing undesirable results.” (Wat. Code, § 10721, subd. (v).) “Undesirable results” includes “significant and unreasonable degraded water quality, including the migration of contaminant plums that impair water supplies.” (Wat. Code, § 10721, subd. (x)(4).) GSPs must be developed for critically overdrafted high- and medium-priority basins by January 31, 2020 (DWR 2016). This deadline applies to the Eastern San Joaquin, Merced, and Chowchilla Subbasins. All other high- or medium-priority basins must adopt GSPs by January 31, 2022. This includes Modesto and Turlock Subbasins.

Each GSP must also include measureable objectives as well as milestones in increments of 5 years, to achieve the sustainability goal in the basin within 20 years of the implementation of the plan. (Wat. Code, § 10727.2.)

If local agencies are unwilling or unable to manage their groundwater resources, SGMA authorizes the State Water Board to step in to protect a groundwater basin in limited circumstances: (1) if no agency has opted by the June 30, 2017 to serve as a GSA for a basin, (2) when a GSA does not complete a GSP by the relevant deadline (2020 or 2022), or (3) when the GSP is inadequate or the GSP is not being implemented in a manner that is likely to achieve the plan's sustainability goal(s), and the basin is either in a condition of long-term overdraft or, after January 31, 2025, the State Water Board determines that the basin is in a condition where groundwater extractions result in significant depletions of interconnected surface waters.

Thus, at this time, local agencies are vested with the mandatory duty to achieve sustainable groundwater management, which includes preventing significant and unreasonable degradation to water quality. These agencies, therefore, can and should exercise their full authorities to address degradation of groundwater quality, both under SGMA and their police powers. Doing so would prevent and/or mitigate private domestic well drinking water supply impacts. Due to inherent uncertainty in the degree to which this mitigation and those listed above may be implemented by local agencies and owners and operators of private domestic wells, drinking water impacts on private domestic wells under LSJR Alternatives 3 and 4 would remain significant and unavoidable.

Impact SP-3: Result in substantial changes to SJR inflows to the Delta such that insufficient water supplies would be available to service providers relying on CVP/SWP exports

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

There would be no reduction in annual average CVP/SWP exports under LSJR Alternative 2 (Section 13.4.2, *Methods and Approach*, and detailed in Chapter 5, *Surface Hydrology and Water Quality*). Modeling results of LSJR Alternative 2 indicate a slight increase in average inflow into the southern Delta from the LSJR. This slight increase in Delta inflow results in an estimated average increase in exports of 18 thousand acre-feet per year (TAF/y). This increase is minimal compared to the historic average annual export of 5,185 TAF/y. As such, under LSJR Alternative 2, the change in exports would be 0 percent of historic average annual exports. Because this change would not reduce the average volume of exported water, it is not expected that service providers relying on exports would experience insufficient water supplies. LSJR Alternative 2, with adaptive implementation method 1, would allow an increase of up to 10 percent over the 20 percent February–June unimpaired flow requirement and, thus, would not reduce the average inflow into the southern Delta from the LSJR. Accordingly, this would not result in a reduction in available water supplies to service providers relying on CVP/SWP exports. As part of LSJR Alternative 2, with adaptive implementation method 2, timing of the release of water within the February–June period would change. By shifting the release time, the shifted release would be affected by different Delta regulations, but the associated change in exports would be relatively small compared to total exports, and the average would not decrease relative to baseline, as a result of overall higher SJR inflow to the Delta. Adaptive implementation method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. LSJR Alternative 2, with adaptive implementation method 4, would allow an adjustment of the Vernalis February–June flow requirement. However, as described under Impact SP-1, changes due to adaptive implementation method 4 under this alternative would rarely alter the flow in the LSJR and, thus, average inflow to the southern Delta would not be changed such that export would be reduced. Impacts would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

There would be no reduction in annual average CVP/SWP exports under LSJR Alternative 3 (Section 13.4.2, *Methods and Approach*, and detailed in Chapter 5, *Surface Hydrology and Water Quality*). Modeling results of LSJR Alternative 3 indicate a slight increase in average inflow into the southern Delta from the LSJR. This slight increase in Delta inflow would result in an estimated average increase in exports of 76 TAF/y. This small increase is approximately 1 percent of the historic average annual export of 5,185 TAF/y. Because this change would not reduce the average volume of exported water, it is not expected that service providers relying on exports would experience insufficient water supplies. LSJR Alternative 3, with adaptive implementation method 1, would allow an increase or decrease of up to 10 percent in the February–June. Effects with a 10 percent decrease would be similar to those described for LSJR Alternative 2, with adaptive implementation method 1. As such, service providers would not be impacted. Adaptive implementation methods 2, 3 and 4 are not expected to result in substantial changes to CVP/SWP exports such that service providers relying on these exports are significantly impacted. LSJR Alternative 3, with adaptive implementation methods 2 or 3, could result in a change to the timing of the release of water within the February–June period. By shifting the release time, the shifted release would be affected by different Delta regulations, but the associated change in exports would be relatively small compared to total exports, and the average volume of exported water would not decrease relative to baseline. Changes in CVP/SWP exports and associated effects on service providers receiving those exports under LSJR Alternative 3 with adaptive implementation method 4 would be similar to LSJR Alternative 2 with adaptive implementation method 4 and as such, service providers would not be significantly impacted. Impacts would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

There would be no reduction in annual average CVP/SWP exports under LSJR Alternative 4 (Section 13.4.2, *Methods and Approach*, and detailed in Chapter 5, *Surface Hydrology and Water Quality*). Modeling results of LSJR Alternative 4 indicate an average increase in inflow into the southern Delta from the LSJR. This increase in Delta inflow results in an estimated average increase in exports of 194 TAF/y. This small increase is approximately 4 percent of the historic average annual export of 5,185 TAF/y. Because this change would not reduce the average volume of exported water, it is not expected that service providers relying on exports would experience insufficient water supplies. LSJR Alternative 4, with adaptive implementation method 1, would allow for a decrease of unimpaired flow to a minimum of 50 percent and would result in an increase in exports; therefore, service providers relying on these exports would not be affected. As part of LSJR Alternative 4 with adaptive implementation methods 2 or 3, timing of the release of water within the February–June period would change. By shifting the release time, the shifted release would be affected by different Delta regulations, but the associated change in exports would be relatively small compared to total exports, and the average volume of exported water would not decrease relative to baseline. Changes in CVP/SWP exports and associated effects on service providers receiving those exports with LSJR Alternative 4 with adaptive implementation method 4 would be similar to LSJR Alternative 2 with adaptive implementation method 4. Impacts would be less than significant.

13.4.4 Impacts and Mitigation Measures: Extended Plan Area

Bypass flows, as described in Chapter 5, *Surface Hydrology and Water Quality*, could be required much more frequently and be larger than under baseline conditions, resulting in potentially less surface water to the 12 service providers identified in the extended plan area in Table 13-6. As such, a small fraction of the water supply effect in the plan area to those service providers relying wholly or in part on surface water to meet water supply needs could be shifted to junior water rights holders in the extended plan area. To the extent that this water supply effect is shifted from agriculture uses downstream in the plan area to consumptive domestic and municipal uses upstream in the extended plan area, the effects on service providers would increase slightly in the extended plan area from that described for the plan area. The service providers identified in Table 13-6 have the potential to have their water supply affected to the extent that their water rights are junior to the senior downstream water right holders.

Under LSJR Alternative 2 without adaptive implementation water supply of downstream senior rights holders would generally be similar to baseline. Therefore, the impacts of LSJR Alternative 2 without adaptive implementation on service providers in the extended plan area would be less than significant.

Similar to the plan area, the extent to which service providers that primarily rely on surface water are affected by a reduction in surface water diversions is a function of their ability to develop alternative water supplies, including water purchases from senior water right holders, or rely on their current existing alternative supplies (e.g., groundwater) under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation. The program of implementation states that the State Water Board will take actions as necessary to ensure implementation of flow objectives does not impact supplies of drinking water for minimum health and safety needs, particularly during drought periods. Actions may include assistance with funding and development of water conservation efforts and regional water supply reliability projects and regulating public drinking water systems and water rights. These actions would be aimed at those service providers supplying water to municipal users and may offset water supply reduction impacts on providers. However, similar to those service providers in the plan area, it is expected that service providers in the extended plan area may need to construct or expand new water treatment facilities or water supply infrastructure to try to accommodate reductions in surface water supplies.

Some of these service providers would be able to implement groundwater pumping to replace some of the bypassed surface water. However, groundwater basins with sufficient quantity to replace the volume required are limited. Some individuals who rely on these service providers may put in their own groundwater wells to supplement that water. Similar to the plan area, significant environmental impacts could occur during construction or operation of new and expanded water facilities and lead agencies can and should implement mitigation measures (listed in Table 16-38). CEQA does not grant agencies new, discretionary powers independent of the powers granted to the agencies by other laws. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040.) Accordingly, a mitigation measure may be legally infeasible if the lead agency does not have the discretionary authority to impose or implement it. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040.) Since the State Water Board would not be responsible for or have discretionary authority to approve the construction of any new or modified facilities or infrastructure, it is not feasible for the State Water Board to impose possible mitigation measures listed in Table 16-38. Moreover, the State Water Boards lacks authority to impose mitigation measures related to impacts such as traffic and noise. Agencies responsible for approving the project-specific new or modified facilities can and should impose the applicable mitigation measures in Table 16-38. Therefore, there is no feasible mitigation the State Water Board can impose to reduce environmental impacts resulting from the need for new or modified facilities or infrastructure. Impacts would be significant and unavoidable. Consequently, under LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, the impacts would be significant and unavoidable for Impact SP-1 in the extended plan area.

The groundwater source area[28] underlying the extended plan area is primarily fractured bedrocks. There is only one DWR Bulletin 118-designated groundwater basin, the Yosemite Valley Basin in Yosemite National Park in Mariposa County, in the extended plan area; the rest of the area is primarily fractured bedrocks. These fracture systems produce relatively small, localized, and isolated groundwater areas. If surface water available to the service providers in the extended plan area is reduced due to implementation of the LSJR alternatives, there could be more groundwater pumping over time in the extended plan area. However, the impact of such an increase in pumping on groundwater quality would be minimal for the following reasons.

- The increase in pumping would be small based on the relatively small amount of total municipal use that occurs in the extended plan area (Section 13.2.2, *Extended Plan Area*).
- The groundwater in the fractured rocks are localized and isolated; hence, the influence of increased pumping on the migration of any contaminants would be minimal.

Thus, impacts on groundwater quality (Impacts SP-2a and SP-2b) would be less than significant in the extended plan area. As discussed in Chapter 5, *Surface Hydrology and Water Quality*, changes on flow upstream of the major rim dams in the Stanislaus, Tuolumne, and Merced Rivers would be small and would not change flows downstream of the rim dams. SJR inflows to the Delta would not be affected even if the extended plan area is taken into consideration. Therefore, impact of the LSJR alternatives with or without adaptive implementation to the service providers relying on CVP/SWP exports (Impact SP-3) would be less than significant.

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[28] Although alluvial aquifers are most common in California, other groundwater development occurs in fractured crystalline rocks, fractured volcanics, and limestones. These nonalluvial areas that provide groundwater are referred to as *groundwater source areas*, while the alluvial aquifers are called *groundwater basins* in DWR Bulletin 118 (DWR 2003a). It is generally referring to areas of fractured bedrock in foothill and mountainous terrain.

13.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

Table 13-3a. Public Water Suppliers in the Eastern San Joaquin, Merced, Modesto, and Turlock Subbasins

Note: This table is first referenced in this chapter in Section 13.2.1, *Lower San Joaquin River and Tributaries*.

Public Water System	Population Served	County Served	Groundwater Subbasin	Groundwater Reliance (%) in 2014
4N Mobile Home Park	165	Stanislaus	Eastern San Joaquin	100
A V Thomas Produce, Inc.	200	Merced	Merced	100
Almond Park Water System	60	San Joaquin	Eastern San Joaquin	100
Atwater	28,100	Merced	Merced	100
Ballico CSD	309	Merced	Turlock	100
Bel Air Mobile Estate	150	San Joaquin	Eastern San Joaquin	100
Black Rascal Water Company	393	Merced	Merced	100
Burson Full Gospel Church	80	Calaveras	Eastern San Joaquin	100
Cal Water, Stockton	185,346	San Joaquin	Eastern San Joaquin	26
Calaveras CWD - Wallace	340	Calaveras	Eastern San Joaquin	100
Castle Airport	2091	Merced	Merced	100
Ceres	42,666	Stanislaus	Turlock	100
Ceres West Mobile Home Park	161	Stanislaus	Turlock	100
City of Modesto	212,000	Stanislaus	Turlock	61
City of Modesto, Central Turlock[b]	116	Stanislaus	Turlock	100
City of Modesto, De #6, So. Turlock	1,279	Stanislaus	Turlock	100
City of Modesto, De Grayson	1,219	Stanislaus	Turlock	100
City of Modesto, De Hayes	200	Stanislaus	Turlock	100
City of Modesto, De Hickman	565	Stanislaus	Turlock	100
City of Modesto, De Hillcrest	1,322	Stanislaus	Modesto	100
City of Modesto, De Walnut Manor	216	Stanislaus	Turlock	100
City of Modesto, De Waterford	7,897	Stanislaus	Modesto	100
City of Modesto, Salida	24,440	Stanislaus	Modesto	100
Clements Water Works #43	120	San Joaquin	Eastern San Joaquin	100
Country Club County WD	85	Merced	Turlock	100
Country Manor Mobile Home Park	75	San Joaquin	Eastern San Joaquin	100

Public Water System	Population Served	County Served	Groundwater Subbasin	Groundwater Reliance (%) in 2014
Country Villa Apartments	30	Stanislaus	Turlock	100
Country Western Mobile Home Park	120	Stanislaus	Turlock	100
Countryside Mobile Home Estates	60	Stanislaus	Turlock	100
Defense Distribution. Depot, Sharpe Site	1,650	San Joaquin	Eastern San Joaquin	100
Delhi CWD	5,640	Merced	Turlock	100
Denair CSD	3,225	Stanislaus	Turlock	100
El Nido Elementary School	210	Merced	Merced	100
El Nido Mobile Home Park	125	Merced	Extended Merced	100
El Torero Restaurant	225	Calaveras	Eastern San Joaquin	100
Elkhorn Estates Water System	200	San Joaquin	Eastern San Joaquin	100
Escalon	7,137	San Joaquin	Eastern San Joaquin	100
Faith Home Teen Ranch	50	Stanislaus	Turlock	100
Farmington Water Company	270	San Joaquin	Eastern San Joaquin	100
Finnlees Trailer Park	55	San Joaquin	Eastern San Joaquin	100
Foster Farms #5	26	Stanislaus	Turlock	100
Gayla Manor PWS	146	San Joaquin	Eastern San Joaquin	100
Glenwood Mobile Home Park	100	San Joaquin	Eastern San Joaquin	100
Green Run Mobile Estates	100	Stanislaus	Turlock	100
Hickman	565	Stanislaus	Turlock	100
Hilmar County WD	4,850	Merced	Turlock	100
Hughson	6,082	Stanislaus	Turlock	100
Islander Marina	150	San Joaquin	Eastern San Joaquin	100
Keyes CSD	4,575	Stanislaus	Turlock	100
Lathrop	12,427	San Joaquin	Eastern San Joaquin	88
Le Grand CSD	1,700	Merced	Merced	100
Linden CWD	1,450	San Joaquin	Eastern San Joaquin	100
Livingston	13,940	Merced	Merced	100
Lockeford CSD	2,500	San Joaquin	Eastern San Joaquin	100
Lodi	63,395	San Joaquin	Eastern San Joaquin	73

Public Water System	Population Served	County Served	Groundwater Subbasin	Groundwater Reliance (%) in 2014
Manteca	66,451	San Joaquin	Eastern San Joaquin	42
Meadowbrook Water Company	6,309	Merced	Merced	100
Merced	80,095	Merced	Merced	100
MID	16	Stanislaus	Turlock	0
Mobile Plaza Park	125	Stanislaus	Turlock	100
Morada Acres Water System	105	San Joaquin	Eastern San Joaquin	100
Morada Estates N PWS #46	180	San Joaquin	Eastern San Joaquin	100
Morada Estates PWS	158	San Joaquin	Eastern San Joaquin	100
Morada Manor Water System	109	San Joaquin	Eastern San Joaquin	85
Oakdale	19,250	Stanislaus	Modesto	100
Oakdale Golf & Country Club (EH)	25	Stanislaus	Modesto	100
Oakwood Lake Water District-Subdivision	43	San Joaquin	Eastern San Joaquin	100
Plainsburg Elementary School	150	Merced	Merced	100
Planada CSD	4,500	Merced	Merced	100
Rancho Marina	75	Sacramento	Eastern San Joaquin	100
Rancho San Joaquin Water Sys	141	San Joaquin	Eastern San Joaquin	100
Ripon	14,915	San Joaquin	Modesto	100
Riverbank	22,201	Stanislaus	Modesto	100
Roberts Ferry School Cafeteria	100	Stanislaus	Modesto	100
San Joaquin County–Colonial Heights	1,851	San Joaquin	Eastern San Joaquin	0
San Joaquin County–Lincoln Village	5,865	San Joaquin	Eastern San Joaquin	0
San Joaquin County-Mokelumne Acres	3,640	San Joaquin	Eastern San Joaquin	100
San Joaquin County-Raymus Village	1,086	San Joaquin	Eastern San Joaquin	100
San Joaquin County–Thornton	957	San Joaquin	Eastern San Joaquin	100
San Joaquin County–Wilkinson Manor	861	San Joaquin	Eastern San Joaquin	100
Sandy Mush Detention Center	800	Merced	Merced	100
SEWD	50	San Joaquin	Eastern San Joaquin	0
Shaded Terrace PWS	161	San Joaquin	Eastern San Joaquin	100
South San Joaquin ID	50	Stanislaus	Modesto	0

Public Water System	Population Served	County Served	Groundwater Subbasin	Groundwater Reliance (%) in 2014
Spring Creek Estates PWS	90	San Joaquin	Eastern San Joaquin	100
Stockton	169,963	San Joaquin	Eastern San Joaquin	23
TID/ La Grange Water System	195	Stanislaus	Turlock	0
Tracy[a]	82,000	San Joaquin	Tracy	3
Turlock	64,215	Stanislaus	Turlock	100
Valley Springs PUD	900	Calaveras	Eastern San Joaquin	100
Walnut Acres	100	San Joaquin	Eastern San Joaquin	100
West Lane Mobile Home Park	160	San Joaquin	Eastern San Joaquin	100
Willow Berm Marina	150	Sacramento	Eastern San Joaquin	100
Winton WSD	8,500	Merced	Merced	100
Total	1,197,140			

Sources: California Environmental Health Tracking Program (CEHTP) Drinking Water Systems Geographic Reporting Tool 2016; State Water Resources Control Board, Division of Drinking Water 2016.

Note: Gray-shaded rows indicate those public water suppliers shown in Table 13-3b.

CSD = Community Services District
CWD = County Water District
ID = Irrigation District
MID = Modesto Irrigation District
PWS = Public Water System
PUD = Public Utilities District
SEWD = Stockton East Water District
WD = Water District

[a] Although the City of Tracy is not located in the Eastern San Joaquin, Modesto, Turlock, or Extended Merced Subbasin, it is within the area of potential effects because it receives water from SSJID and can be affected by the LSJR alternatives. Therefore, it is included in this table.

[b] The City of Modesto, Central Turlock has no groundwater wells, but purchases groundwater from Turlock.

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Chapter 14
Energy and Greenhouse Gases

14.1 Introduction

This chapter describes the environmental setting and overall regulatory framework for energy and greenhouse gases (GHGs). It also evaluates environmental impacts on energy and climate change that could result from the Lower San Joaquin River (LSJR) alternatives and, if applicable, offers mitigation measures that would reduce significant impacts.

The area of potential effects evaluated in this chapter includes the plan area, described in Chapter 1, *Introduction,* and the Central Valley Project (CVP) and State Water Project (SWP) export service areas. However, once emitted from their sources, GHGs become free to move within the atmosphere and can travel far away from their sources during their lifetimes. In addition, climate change is a global issue and GHGs are global pollutants, unlike criteria air pollutants (such as ozone precursors), which are primarily pollutants of regional and local concern. No single emitter of GHGs is large enough to trigger climate change on its own. Hence, the discussion of GHGs and climate change in this chapter extends outside of the plan area to evaluate the impacts on *climate change* of GHG emissions generated within the plan area.

The extended plan area, also described in Chapter 1, generally includes the area upstream of the rim dams. [1] It also includes the reservoirs on the upper reaches of the Stanislaus, Tuolumne, and Merced Rivers. Unless otherwise noted, all discussion in this chapter refers to the plan area. Where appropriate, the extended plan area is specifically identified.

The LSJR alternatives propose specified unimpaired flow[2] (i.e., 20, 40 or 60 percent) requirements on the three eastside tributaries[3] in February–June. Such requirements could affect reservoir operations, surface water diversions, and the associated timing and amount of hydropower generated by dams on the three eastside tributaries. This chapter evaluates the effects on hydropower production, electric grid reliability, and the resulting increase in energy consumption in the plan area that would result from the LSJR alternatives. This chapter also evaluates the effects of the LSJR alternatives on climate change and GHG emissions.

In Appendix B, *State Water Board's Environmental Checklist*, the State Water Board determined whether the plan amendments[4] would result in any adverse impact on resources in each environmental category in the checklist and provided a brief explanation for its determination. Impacts that are listed as "Potentially Significant Impacts" are discussed in detail in this chapter.

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[1] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

[2] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

[3] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[4] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

Appendix B, Section VII, identified the alternatives as having potentially significant impacts relating to GHG emissions, because they might: (1) generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment; and (2) conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHGs. In order to analyze these potential impacts, GHG impacts were generally evaluated on exceedance of regulatory thresholds that could negatively impact the environment and long-term management implications affecting climate change.

As stated in Appendix B, Section VII, the general historical range of salinity in the southern Delta would remain unchanged under the SDWQ alternatives and, thus, would not result in GHG emissions or conflict with an applicable plan, policy or regulation adopted for the purpose of reducing GHG emissions. Therefore, the SDWQ alternatives are not further analyzed in this chapter, except as they relate to the effect of climate change on the alternatives. SDWQ Alternative 2 could result in service providers having to construct and operate new or expanded wastewater treatment or water supply facilities, which would involve changes in energy consumption and GHG emissions, and is evaluated in Chapter 13, *Service Providers*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions.*

The State Water Board determined that additional types of potentially significant adverse impacts that are not listed in the checklist in Appendix B should be evaluated. Accordingly, this chapter also evaluates the LSJR alternatives' impacts on energy resources that either may potentially (1) adversely affect the reliability of California's electric grid, or (2) result in inefficient, wasteful, and unnecessary energy consumption. The detailed discussion regarding the hydropower production on the LSJR's three eastside tributaries, the electric grid reliability, and the surface water diversions is presented in Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*, Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling.*

A summary of the potential impacts of the LSJR alternatives on energy and GHG emissions is provided in Table 14-1. As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 each include four methods of adaptive implementation. Table 14-1 also considers the effect of climate change on the LSJR and SDWQ alternatives. This recirculated substitute environmental document (SED) provides an analysis with and without adaptive implementation because the frequency, duration, and extent to which each adaptive implementation method would be used, if at all, within a year or between years under each LSJR alternative, is unknown. The analysis, therefore, discloses the full range of impacts that could occur under an LSJR alternative, from no adaptive implementation to full adaptive implementation. As such, Table 14-1 summarizes impact determinations with and without adaptive implementation.

Impacts related to the No Project Alternative (LSJR/SDWQ Alternative 1) are presented in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* and the supporting technical analysis is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* Impacts related to methods of compliance are discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

Table 14-1. Summary of Energy and Greenhouse Gases Impact Determinations

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact EG-1: Adversely affect the reliability of California's electric grid			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA
LSJR Alternatives 2 and 3	Transmission line loadings would not exceed the limits under contingency outage conditions because hydropower generation and reservoir elevation would not be substantially modified. Therefore, adverse effects on the reliability of California's electric grid would not occur.	Less than significant	Less than significant
LSJR Alternative 4	Transmission line loadings would not exceed the limits under contingency outage conditions after re-dispatch of generator facilities to correct a minor violation between Borden and Gregg substations and Gregg and Storey substations. Re-dispatches are regular occurrences in the California energy grid, and they provide a solution to redistribute power. Therefore, adverse effects on the reliability of California's electric grid would not occur.	Less than significant	Less than significant
Impact EG-2: Result in inefficient, wasteful, and unnecessary energy consumption			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA
LSJR Alternatives 2, 3, and 4	Additional groundwater pumping would not result in inefficient, wasteful, and unnecessary consumption of energy to the extent groundwater pumping is used to meet water supply irrigation demand in accordance with state law. Additional energy generation at other facilities to compensate for a potential loss of hydropower would not be considered inefficient, wasteful, and unnecessary as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. Therefore, there would be no inefficient, wasteful, or unnecessary energy consumption.	Less than significant	Less than significant

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
Impact EG-3: Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Significant	NA
LSJR Alternative 2	Emissions would not exceed 10,000 MT CO_2e threshold, even if adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%). Therefore, GHG emissions would not have a significant impact on the environment.	Less than significant	Less than significant
LSJR Alternatives 3 and 4	Emissions exceed 10,000 MT CO_2e threshold with and without adaptive implementation. Therefore, GHG emissions would have a significant impact on the environment.	Significant and unavoidable	Significant and unavoidable
Impact EG-4: Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Significant	NA
LSJR Alternative 2	Since GHG emissions would not exceed the 10,000 MT CO_2e threshold, even if adaptive implementation method 1 were implemented on a long-term basis, there would be no conflict with applicable plans, policies or regulations adopted for the purpose of reducing GHGs.	Less than significant	Less than significant
LSJR Alternatives 3 and 4	Since GHG emissions would exceed the 10,000 MT CO_2e threshold, with and without adaptive implementation, it is expected there would be a conflict with applicable plans, policies or regulations adopted for the purpose of reducing GHGs.	Significant and unavoidable	Significant and unavoidable
Impact EG-5: Effect of climate change on the LSJR and SDWQ alternatives			
No Project Alternative (LSJR/SDWQ Alternative 1)	See note. [b]	Less than significant	NA

Alternative	Summary of Impact(s)	Impact Determination without Adaptive Implementation	Impact Determination with Adaptive Implementation[a]
LSJR Alternatives 2, 3, and 4	Climate change would not significantly affect the LSJR alternatives because adaptive implementation would allow agencies to respond to changing circumstances with respect to flow and water quality that might arise due to climate change. Furthermore, the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning such as climate change.	Less than significant	Less than significant
SDWQ Alternatives 2 and 3	Climate change would not significantly affect the SDWQ alternatives because the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning, such as climate change.	Less than significant	NA

MT = metric ton
CO_2e = carbon dioxide equivalent
WQCP = water quality control plan

[a] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in Section 14.4.2, *Methods and Approach,* of this chapter.

[b] The No Project Alternative (LSJR/SDWQ Alternative 1) would result in implementation of flow objectives and salinity objectives established in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

14.2 Environmental Setting

14.2.1 Lower San Joaquin River and Eastside Tributaries Hydropower Production

There are numerous hydropower generation plants on the three eastside tributaries. The major power plants are those associated with the New Melones Reservoir (New Melones Dam) on the Stanislaus River, New Don Pedro Reservoir (New Don Pedro Dam) on the Tuolumne River, and Lake McClure (New Exchequer Dam) on the Merced River. The total hydropower generation capacity of the three eastside tributaries combined is about 803 megawatts (MW), and the three facilities considered here represent 87 percent of the total capacity of the three eastside tributaries (Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*). Table 14-2a lists the hydropower facilities in the plan area and extended plan area. Table 14-2b shows the characteristics of the three major hydropower plants on the tributaries—New Melones, New Don Pedro, and New Exchequer. The head for each of the major hydropower plants is the difference between the maximum elevation and tail-water elevation and the corresponding maximum capacity of the power plants.

Table 14-2a. List of Hydropower Facilities

River Basin	Hydroelectric Power Plant Name	Nameplate Capacity (MW)	% of Power Capacity in Basin	Location Relative to Rim Dams
Stanislaus	Woodward	2.85	0.4	Off-stream
	Frankenheimer	5.04	0.6	Off-stream
	Tulloch	17.10	2.2	Inline
	Angels	1.40	0.2	Upstream
	Phoenix	1.60	0.2	Upstream
	Murphys	4.50	0.6	Upstream
	New Spicer	6.00	0.8	Upstream
	Spring Gap	6.00	0.8	Upstream
	Beardsley	9.99	1.3	Upstream
	Sand Bar	16.20	2.1	Upstream
	Donnells-Curtis	72.00	9.2	Upstream
	Stanislaus	91.00	11.6	Upstream
	Collierville Ph	249.10	31.8	Upstream
	New Melones	300.00	38.3	Rim Dam
	Upstream Capacity	457.79	58.5	NA
	Affected Capacity	324.99	41.5	NA
Tuolumne	Stone Drop	0.20	0.0	Off-stream
	Hickman	1.08	0.2	Off-stream
	Turlock Lake	3.30	0.5	Off-stream
	La Grange	4.20	0.7	Inline
	Upper Dawson	4.40	0.7	Upstream
	Moccasin Lowhead	2.90	0.5	Upstream
	Moccasin	100.00	16.6	Upstream
	R C Kirkwood	118.22	19.6	Upstream
	Dion R. Holm	165.00	27.4	Upstream
	Don Pedro	203.00	33.7	Rim Dam
	Upstream Capacity	390.52	64.8	NA
	Affected Capacity	211.78	35.2	NA
Merced	Fairfield	0.90	0.8	Off-stream
	Reta - Canal Creek	0.90	0.8	Off-stream
	Merced ID – Parker	3.75	3.2	Off-stream
	Mcswain	9.00	7.6	Inline
	Merced Falls	9.99	8.4	Inline
	New Exchequer	94.50	79.4	Rim Dam
	Upstream Capacity	0.00	0.0	NA
	Affected Capacity	119.04	100%	NA

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*, Table J-1.
MW = megawatts
NA = not applicable

Table 14-2b. Elevation and Maximum Capacity at Major Hydropower Plants on Eastside Tributaries

Power Plant	Maximum Elevation (feet)	Tail-water Elevation (feet)	Headwater (feet)	Maximum Capacity (MW)
New Melones	1,088	503	585	300
New Don Pedro	830	310	520	203
New Exchequer	867	400	467	95

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.
MW = megawatts

The existing hydropower production was estimated for the various power plants on the three eastside tributaries. Actual hydropower generation in any given period is variable and depends on the amount of surface water captured and stored in the reservoir during wet and dry years; Table 14-3 summarizes the average annual hydropower generation on each of the three eastside tributaries to provide an overall sense of hydropower generation.

Table 14-3. Annual Baseline Hydropower Generation on LSJR Eastside Tributaries

LSJR Tributary	Average Annual Hydropower Generation (GWh)
Stanislaus River	586
Tuolumne River	656
Merced River	408
Project-Wide Total	1,650

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*. Baseline conditions are those from the baseline WSE model simulation.
GWh = gigawatt hours

14.2.2 Transmission System in Central California

This section provides a brief overview of the transmission systems and the balancing authorities for the areas in which the New Melones, New Don Pedro, and New Exchequer hydropower plants are located. According to the North American Electric Reliability Corporation (NERC), a balancing authority is defined as the responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance and supports interconnection frequency in real time. The balancing authorities are listed in Table 14-4 and discussed in the sections below. This information provides context for the capacity reduction calculation and power flow analysis discussed below in Section 14.4.2, *Methods and Approach*.

Table 14-4. Balancing Authority of Major Hydropower Plants on LSJR Eastside Tributaries

Power Plant	Balancing Authority
New Melones	Balancing Authority of Northern California (BANC)
New Don Pedro	Turlock Irrigation District (TID—68%) and Sacramento Municipal Utility District (SMUD)—32%
New Exchequer	California Independent System Operator (CAISO)

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.

Note: Don Pedro hydropower plant is jointly owned by TID and Modesto Irrigation District (MID). BANC performs the balancing authority function for MID's portion of the plant, while TID is the balancing authority for its portion. SMUD is a member of BANC.

California Independent System Operator

The New Exchequer hydropower plant lies in the Greater Fresno local capacity areas. These are areas that are transmission-constrained and require a certain minimum amount of local generation for meeting the local load requirements. California Independent System Operator (CAISO) operates the high-voltage, long-distance power lines that make up 80 percent of California's wholesale power grid. It is responsible for system reliability in the local capacity areas and other areas throughout California by scheduling available transmission capacity. The California Public Utilities Commission (CPUC) adopted the Resource Adequacy (RA) program in 2004 with the twin objectives of (1) providing sufficient resources to CAISO to ensure the safe and reliable operation of the grid in real time, and (2) providing appropriate incentives for the siting and construction of new resources needed for reliability in the future (CPUC 2011). Each year CAISO performs the Local Capacity Technical (LCT) Study to identify local capacity requirements (LCRs) within its territory. The results of this study are provided to CPUC for consideration in its RA program. These results are also be used by CAISO for identifying the minimum quantity of local capacity necessary to meet the NERC reliability criteria used in the LCT Study (CAISO 2010). Table 14-5 shows the historical local capacity requirements, peak load, and total dependable local area generation for the Greater Fresno area. The table also shows the local capacity area as a percentage of the total dependable local generation. For example, in 2011, the LCR in Greater Fresno was 2,448 MW, while the peak load stood at 3,306 MW; the LCR was 74 percent of the peak load. At the same time, the total dependable generation stood at 2,919 MW, which meant that the LCR was 84 percent of the total dependable generation. In other words, in 2011, Greater Fresno had sufficient local resources available to meet its local capacity requirements. As previously mentioned, these are minimum generation requirements imposed on transmission-constrained regions within the state.

Table 14-5. Local Capacity Requirements versus Peak Load and Local Area Generation for Greater Fresno Area

Year	Local Capacity (MW)	Peak Load (MW)	Local Capacity as % of Peak Load	Dependable Local Generation (MW)	Local Capacity Area as % of Dependable Local Generation
2006	2,837	3,117	91	2,651	107
2007	2,219	3,154	70	2,912	76
2008	2,382	3,260	73	2,991	80
2009	2,680	3,381	79	2,829	95
2010	2,640	3,377	78	2,941	90
2011	2,448	3,306	74	2,919	84

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.
MW = megawatts

In the CAISO board of governors-approved 2010/2011 transmission plan, CAISO identified a number of transmission upgrades that are needed in the Greater Fresno area to maintain system reliability between 2011 and 2020. Pacific Gas & Electric Company (PG&E) proposed a number of projects to maintain system reliability in the area (CAISO 2011).

Balancing Authority of Northern California/Sacramento Municipal Utility District

The Balancing Authority of Northern California (BANC) is a joint powers authority comprised of the Sacramento Municipal Utility District (SMUD), MID, Roseville Electric, Redding Electric Utility and Trinity Public Utility District. The third largest balancing authority in California, BANC, assumed balancing authorities from SMUD in in 2011.

SMUD, established in 1946, is the nation's sixth largest community-owned electric utility in terms of customers served (approximately 590,000) and covers a 900-square-mile area that includes Sacramento County and a small portion of Placer County. While the New Melones power plant physically resides in the CAISO balancing authority area, Sierra Nevada Region (SNR), Sacramento SMUD, and CAISO operate New Melones as a pseudo-tie generation export from CAISO into the SMUD balancing authority area (Western Area Power Administration 2010). The pseudo-tie generation export arrangement implies that New Melones is electrically and operationally included as part of the SMUD balancing authority area. For purposes of Qualifying Capacity, SNR has designated the New Melones power plant as part of the CVP resource in the SMUD balancing authority area.

As part of the biennial resource adequacy and resource plan assessments for publically owned utilities, the California Energy Commission (CEC) published its biennial report in November 2009 detailing the need and availability of generation resources to meet the future load and planning reserve margin requirements within the territory of publically owned utilities (CEC 2009a). The report indicates that SMUD will be able to meet its resource adequacy requirements in the near term; however, in 2018, SMUD's generation resources may not be sufficient to meet its load and planning reserve margin obligations. The expected deficiency in 2018 is estimated to be 347 MW, but the CEC does not expect this to be an issue due to the lead time available to resolve the expected deficiency.

SMUD also carries out an annual 10-year transmission planning process to ensure that NERC and Western Electricity Coordinating Council (WECC) Reliability Standards are met each year of the 10-year planning horizon. Major projects that have been proposed in the 2010 transmission plan for the 2016–2020 time period are expected to improve the reliability of SMUD's electric system as well as increase its load-serving capability.

Turlock Irrigation District

The Turlock Irrigation District (TID) operates as a balancing authority located between Sacramento and Fresno in California's Central Valley (California Transmission Planning Group). Westley 230 kilovolt (kV) and Oakdale 115 kV lines provide import access for TID. The TID balancing authority incorporates all 662 square miles of TID's electric service territory as well as a 115 kV loop with three 115 kV substations owned by the Merced Irrigation District (Merced ID). The Merced ID facilities are interconnected to TID's August and Tuolumne 115 kV substations and are located just south of TID's service territory and north of the city of Merced. TID is the majority owner and operating partner of the New Don Pedro power plant with 68.46 percent ownership, and MID has a 31.54 percent ownership. BANC performs the balancing authority function for MID's portion of the plant.

14.2.3 Climate Change

The phenomenon known as the *greenhouse effect* keeps Earth's atmosphere near the surface warm enough for successful habitation by humans and other forms of life. GHGs present in the earth's lower atmosphere play a critical role in maintaining Earth's temperature as they trap some of the long-wave infrared radiation emitted from Earth's surface that otherwise would have escaped to space.

The accelerated increase of fossil fuel combustion and deforestation since the Industrial Revolution of the nineteenth century has exponentially increased concentrations of GHGs in the atmosphere. Increases in the atmospheric concentrations of GHGs in excess of natural ambient concentrations increase the natural greenhouse effect.

This increased greenhouse effect has contributed to global warming, which is the gradual increase of Earth's average surface temperature over a long term. Specifically, increases in GHGs lead to increased absorption of long-wave infrared radiation by the earth's atmosphere and further warm the lower atmosphere, thereby increasing evaporation rates and temperatures near the surface. Warming of Earth's lower atmosphere induces large-scale changes in ocean circulation patterns, precipitation patterns, global ice cover, biological distributions, and other changes to Earth's systems that are collectively referred to as *climate change*.

The Intergovernmental Panel on Climate Change (IPCC) has been established by the World Meteorological Organization and United Nations Environment Programme to assess scientific, technical, and socioeconomic information relevant to the understanding of climate change, its potential impacts, and options for adaptation and mitigation. The IPCC estimates that the average global temperature rise between the years 2000 and 2100 could range from 1.1°C, with no increase in GHG emissions above year 2000 levels, to 6.4°C, with substantial increase in GHG emissions (IPCC 2007). Large increases in global temperatures could have massive deleterious impacts on the natural and human environments.

Principal Greenhouse Gases

GHGs are gases that trap heat in the atmosphere. GHGs are both naturally occurring and artificial. Examples of GHGs that are produced both by natural and anthropogenic (human-made) processes are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Examples of GHGs created and emitted primarily through human activities are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The primary GHGs generated by the LSJR alternatives—CO_2, CH_4, and N_2O—are discussed below.

The IPCC estimates that CO_2 accounts for more than 75 percent of all anthropogenic GHG emissions. Three quarters of anthropogenic CO_2 emissions are the result of fossil fuel burning, and approximately one quarter result from land use change (IPCC 2007). CH_4 is the second largest contributor of anthropogenic GHG emissions and is the result of growing rice, raising cattle, combustion, and mining coal. N_2O, while not as abundant as CO_2 or CH_4, is a powerful GHG. Sources of N_2O include agricultural processes, nylon production, fuel-fired power plants, nitric acid production, and vehicle emissions.

In order to simplify reporting and analysis, methods have been set forth to describe emissions of GHGs in terms of a single gas. The most commonly accepted method to compare GHG emissions is the global warming potential (GWP) defined in the IPCC reference documents (IPCC 1996, 2001). The IPCC defines the GWP of various GHGs on a normalized scale that recasts all GHG emissions in terms of carbon dioxide equivalent (CO_2e). Hence, GWP is a measure of a gas's heat-absorbing capacity and lifespan relative to a reference gas, CO_2 (CO_2 has a GWP of 1, by definition).

Table 14-6 lists the global warming potential of CO_2, CH_4, and N_2O; their lifetimes; and abundances in the atmosphere in parts per million (ppm) and parts per trillion (ppt).

Table 14-6. Lifetime and Global Warming Potentials

GHG	Global Warming Potential (100 years)	Lifetime (years)	Current Atmospheric Abundance (ppm)
CO_2	1	50–200	399
CH_4	28	12.4	1,893
N_2O	265	121	326

Sources: IPCC 2013; Carbon Dioxide Information Analysis Center 2014; CO2Now.org 2015.
GHG = greenhouse gas
ppm = parts per million

Greenhouse Gas Emissions Inventories

A GHG inventory is a quantification of GHG emissions and sinks within a selected physical and/or economic boundary over a specified time. GHG inventories can be performed on a large scale (i.e., for global and national entities) or on a small scale (i.e., for a particular building or person). GHG sinks typically refer to removals of GHGs from the atmosphere as a result of carbon sequestration. Carbon sequestration is the process by which plants absorb and store atmospheric CO_2.

Table 14-7 outlines the most recent global, national, and statewide GHG inventories to help contextualize the magnitude of potential alternative-related emissions. Figures 14-1, 14-2, and 14-3 show global, national, and state GHG emissions by source/sector, respectively.

Table 14-7. Global, National, and State Greenhouse Gas Emissions Inventories

Emissions Inventory	Total GHG Emissions and Sinks in CO_2e (metric tons)
2010 IPCC Global GHG Emissions Inventory	52,000,000,000
2013 USEPA National GHG Emissions Inventory	6,673,000,000
2013 ARB State GHG Emissions Inventory	459,280,000

Sources: IPCC 2014; USEPA 2015a; ARB 2015.
IPCC = Intergovernmental Panel on Climate Change
GHG = greenhouse gas
USEPA = U.S. Environmental Protection Agency
ARB = California Air Resources Board

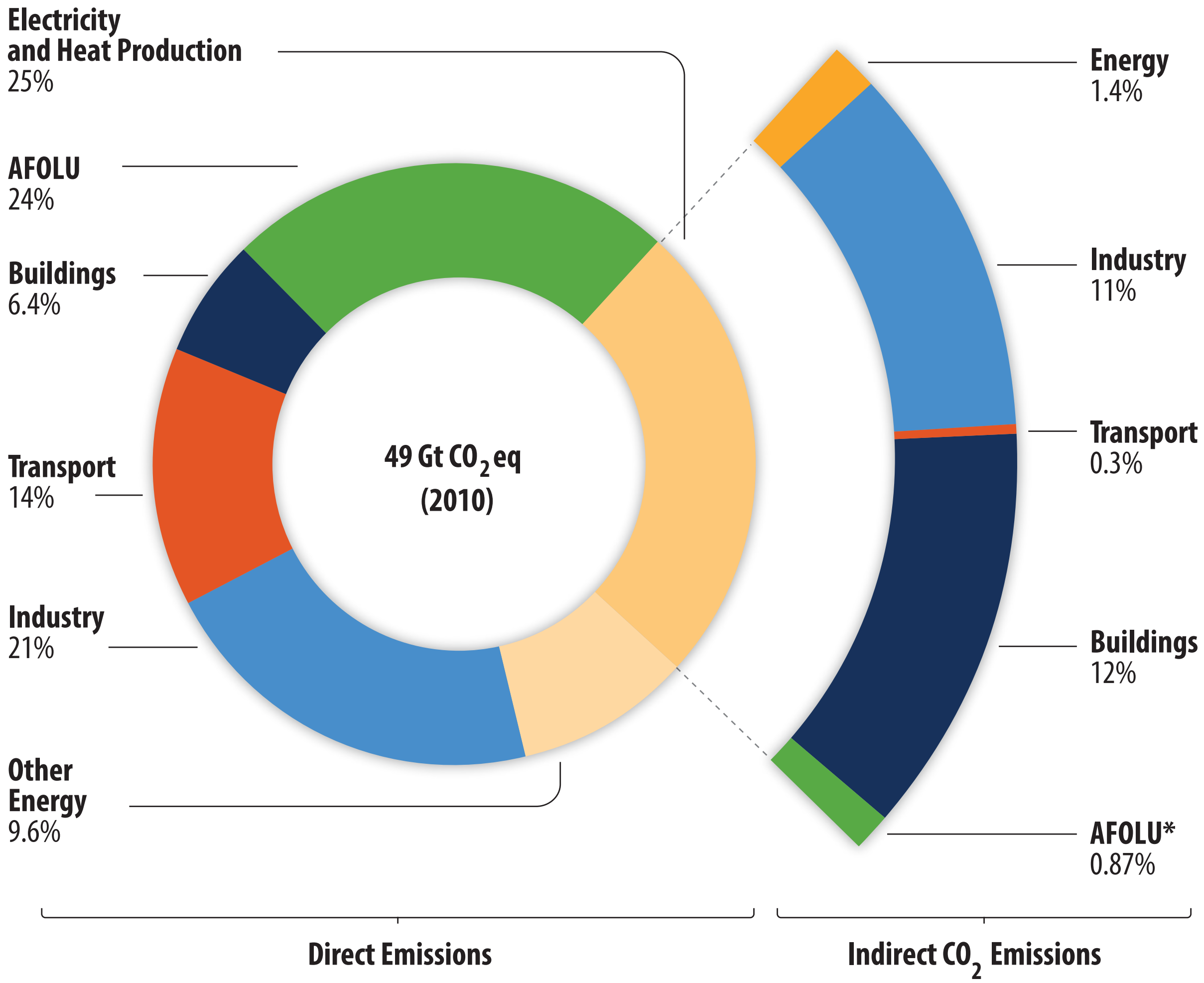
GHG Emissions in the Plan Area and Extended Plan Area

There is no regional GHG inventory for the plan area or extended plan area. There are some local inventories for individual jurisdictions, but there is currently no assessment of GHG emissions for the Central Valley region or Mountain region as a whole. However, primary sources of GHG emissions in the plan area include those described above under the statewide emissions by source, such as: on-road transportation from vehicle travel, residential and nonresidential building energy use, and agricultural activity including off-road equipment fuel combustion, fugitive emissions from livestock production (enteric fermentation and manure management), and fertilizer application. Primary sources of GHG emissions in the extended plan area are similar to those described above under the statewide emissions by sources and in the plan area; however, there is expected to be less agricultural activity related emissions given the relatively limited amount of agriculture in the extended plan area when compared to the plan area and the rest of the state.

Climate Change Effects on State Climate Trends

Climate change is a complex phenomenon that has the potential to alter local climatic patterns and meteorology. Although modeling indicates that climate change will result in such things as sea level rise and changes in regional climate and rainfall, a high degree of scientific uncertainty still exists with regard to characterizing future climate characteristics and predicting how various ecological and social systems will react to any changes in the existing climate at the local level. Regardless of this uncertainty, it is widely understood that some form of climate change is expected to occur in the future.

Several recent studies have attempted to characterize future climatic scenarios for California. While specific estimates and statistics on the severity of changes vary, sources agree that the San Joaquin Valley and the Delta will witness warmer temperatures, increased heat waves, and changes in rainfall patterns. In addition, reduced snow pack and stream flow in the Sierra Nevada could lead to changes in water supply into the Delta region. Specifically, the CEC estimates that average annual temperatures in the state will increase by approximately 1°C–3°C between 2010 and mid-century, according the model for the Sacramento region. Climatic models also predict that between 2035 and 2064, the number of heat wave days for the Sacramento region will increase by more than 100 days,

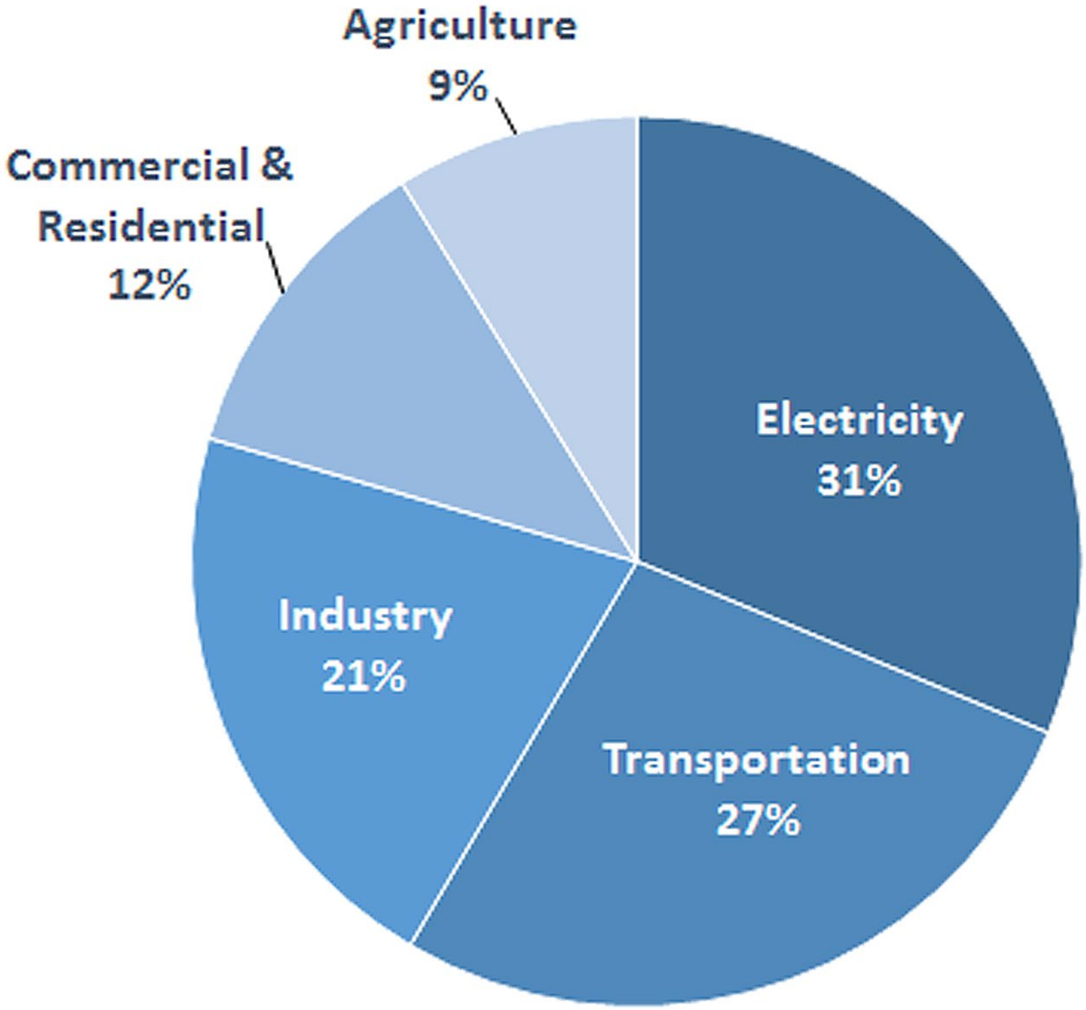


* AFOLU = Agriculture, Forestry and Other Land Use

Source: IPCC, 2014.

Graphics...00427.11 (6-9-2016)

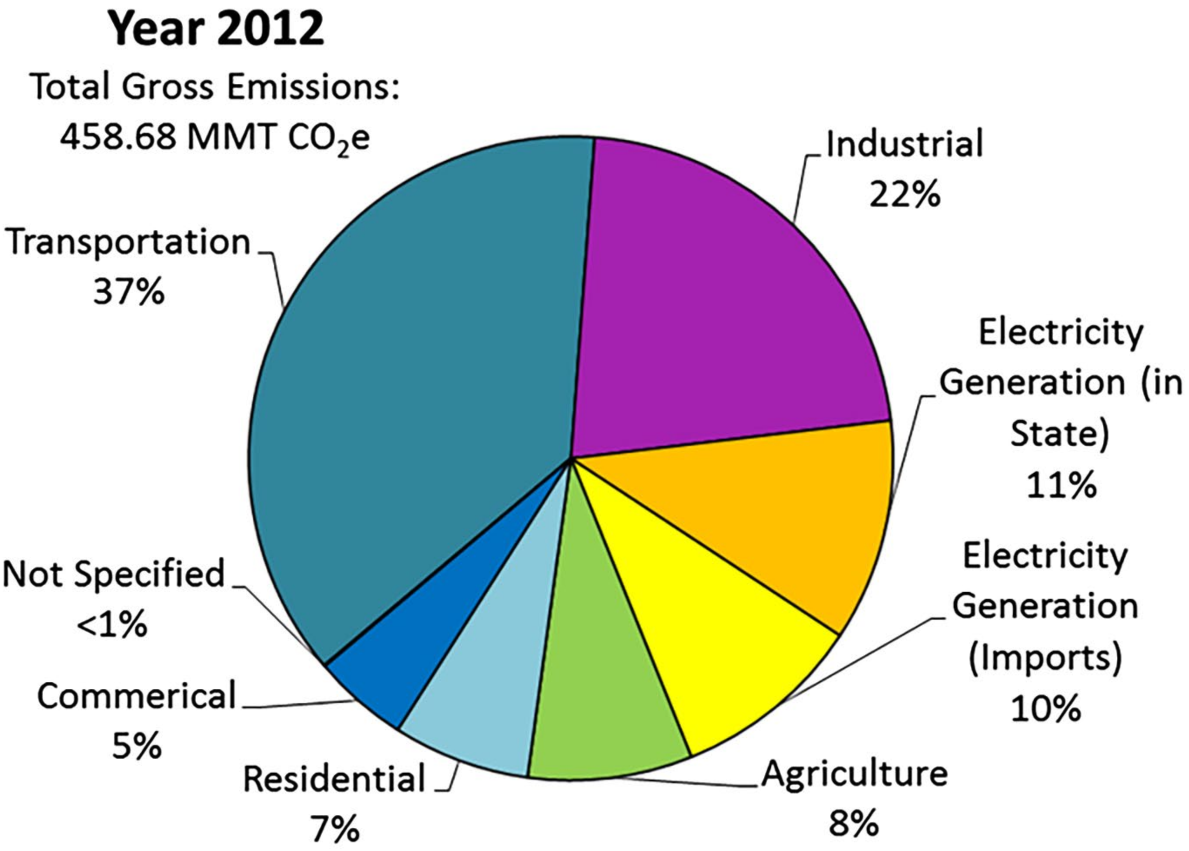
Figure 14-1
Global GHG Emissions by Source



Source: USEPA, 2015.

Graphics...00427.11 (6-19-2015)

Figure 14-2
National GHG Emissions by Source



Source: ARB, 2014.

Graphics…00427.11 (6-19-2015)

Figure 14-3
Statewide GHG Emissions by Source

relative to the previous 30-year period between 2005 and 2034. Annual precipitation may experience a declining trend, but remain highly variable, suggesting that the Sacramento Valley will be vulnerable to increased drought. Warmer temperatures will lead to increased precipitation in the form of rain, both of which will contribute to decreased snowpack in the Sierra Nevada. Such effects will translate into earlier snowmelt and increased potential for flooding as a result of insufficient reservoir capacity to retain earlier snowmelt. (IPCC 2007; California Natural Resources Agency 2009; CEC 2009b; USBR 2016).

Sea level rise during the next 50 years is expected to increase dramatically over historical rates. The CEC predicts that by 2050, sea level rise, relative to the 2000 measurements, will range from 30 to 45 centimeters. Coastal sea level rise could result in saltwater intrusion to the Delta and associated biological impacts in the San Joaquin Valley. Changes in soil moisture and increased risk of wildfires also may dominate future climatic conditions in the area. (IPCC 2007; California Natural Resources Agency 2009; CEC 2009b).

The changes in temperature, precipitation and sea level may have substantial effects on other resources areas. The primary effects of climate change anticipated in California are listed below (California Natural Resources Agency 2009).

- Increased average temperatures (air, water, and soil).
- Reduced or slightly increased annual precipitation amounts.
- Change from snowfall (and spring snowmelt) to rainfall.
- Decreased Sierra snowpack (earlier runoff, reduced maximum storage).
- Increased evapotranspiration.
- Increased frequency and intensity of Pacific storms (flood events).
- Increased severity of droughts.
- Increased frequency and severity of extreme heat events.
- Increased frequency and severity of wildfire events.
- Sea level rise (with increased salt water intrusion in the Delta).
- Changes in species distribution and ranges.
- Decreased number of species.
- Increased number of vector-borne diseases and pests (including impacts on agriculture).
- Altered timing of animal and plant lifecycles (phenology).
- Disruption of biotic interactions (e.g., predator-prey relationships amongst species and increased invasive species abundance).
- Changes in physiological performance, including reproductive success and survival of plants and animals.
- Increase in invasive species.
- Altered migration patterns of fishes, aquatic-breeding amphibians, birds, and mammals.
- Changes in food (forage) base.
- Changes in habitat, vegetation structure, and plant and animal communities.

DWR (2010a) analyzed the flows of the four rivers in the SJR Watershed (Stanislaus, Tuolumne, Merced, and San Joaquin). This report documented that the combined unimpaired runoff from April–July has declined by approximately 7 percent relative to the total water year runoff over the past 100 years. Therefore, while total runoff in these watersheds has decreased, April–July runoff has decreased at a greater rate (DWR 2010a). USBR has also evaluated flows under climate change scenarios within the Sacramento-San Joaquin River Basin concluding that the basin will experience a shift in runoff to more during late fall and winter and less during the spring as a result of more precipitation, higher temperatures during the winter, and less snowpack (USBR 2016). As a result, reservoirs in the basin, including New Melones, New Don Pedro, and Lake McClure, are likely to fill earlier and release excess runoff, thereby potentially limiting overall storage capability and reducing water supply (USBR 2014, 2016). These changes have implications for water quality, water supply, flooding, aquatic ecosystems, energy generation, and recreation throughout the region (USBR 2014, 2016).

Guidance documents have been drafted and published to discuss strategies to protect resources from climate change in California (e.g., the *State of California Sea-Level Rise Interim Guidance Document*, Coastal and Ocean Working Group of the California Climate Action Team 2010). Many federal, state, and local agencies are incorporating adaptive strategies into their planning processes and planning documents to account for the potential changes in water resources and the effect on water supply reliability and other factors (see Sections 14.3.2, *State [Regulatory Background]*, and 14.3.3, *Regional or Local [Regulatory Background]*, regarding state and local planning documents related to climate change).

14.3 Regulatory Background

The legal framework addressing climate change regulatory background is complex and evolving. This section identifies key legislation, executive orders, as well as plans and policies relevant to the environmental assessment of GHG emissions.

14.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to GHG emissions are described below.

Mandatory Greenhouse Gas Reporting Rule

On September 22, 2009, the U.S. Environmental Protection Agency (USEPA) released its final Greenhouse Gas Reporting Rule (Reporting Rule). The Reporting Rule is a response to the fiscal year (FY) 2008 Consolidated Appropriations Act (H.R. 2764; Public Law 110-161), which required USEPA to develop "… mandatory reporting of GHGs above appropriate thresholds in all sectors of the economy…." The Reporting Rule would apply to most entities that emit 25,000 metric tons (MT) of CO_2e or more per year. Starting in 2010, facility owners are required to submit an annual GHG emissions report with detailed calculations of facility GHG emissions. The Reporting Rule also would mandate recordkeeping and administrative requirements in order for USEPA to verify annual GHG emissions reports. All electrical distribution utilities (EDU) except Investor-Owned Utilities (IOUs) must comply with the Reporting Rule. This includes SMUD and TID, which are within the plan area.

Omnibus Public Land Management Act

The Omnibus Public Land Management Act, also known as the SECURE Water Act, was passed by Congress in 2009. This act establishes that Congress finds that adequate and safe supplies of water are fundamental to the health, economy, security, and ecology of the United States although global climate change poses a significant challenge to the protection of these resources. The act authorized USBR to continually evaluate and report on the risks and impacts from a changing climate and to identify appropriate adaptation and mitigation strategies using the best available science in conjunction with stakeholders. USBR has released several reports under the SECURE Water Act, the first of which was released in 2011. The reports address the requirements of the act including: each effect of, and risk resulting from, global climate change with respect to the quantity of water resources located in each major USBR river basin; impact of global climate change with respect to the operations of the secretary in each major river basin; each mitigation and adaptation strategy considered and implemented; each coordination activity conducted by the U.S. Geological Survey, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, or other resource agency (USBR 2011).

Since USBR maintains and operates reservoirs in the SJR Basin (e.g., New Melones Reservoir) these reports include information regarding the basin and effects of climate change. They also contain a wide variety of recommendations for responding to resource changes under climate changes (USBR 2016). These include the following potential adaptation strategies to address vulnerability: agricultural water use and municipal and industrial water use efficiency, ocean desalination; precipitation enhancement; conjunctive management; improvements of CVP/SWP operations; improvement of tributary and Delta environmental inflows; enhance groundwater recharge; increase San Joaquin Valley surface storage; improve regulatory flexibility and adaptation; improve river temperature management; and improve salinity and nutrient management (USBR 2016).

14.3.2 State

Relevant state laws, programs, policies, plans, or regulations related to GHG emissions are described below.

Executive Order S-3-05

Signed by Governor Arnold Schwarzenegger on June 1, 2005, Executive Order S-3-05 asserts that California is vulnerable to the effects of climate change. To combat this concern, Executive Order S-3-05 established the following GHG emissions reduction targets for state agencies.

- By 2010, reduce GHG emissions to 2000 levels.
- By 2020, reduce GHG emissions to 1990 levels.
- By 2050, reduce GHG emissions to 80 percent below 1990 levels.

Executive Order S-13-08

Executive Order S-13-08, signed by Governor Schwarzenegger in November 2008, requires the California Natural Resources Agency to develop a state Climate Adaptation Strategy in coordination with local, regional, state and federal public and private entities. The National Academy of Sciences must convene an independent panel to complete the first California Sea Level Rise Assessment Report, which will advise how California should plan for future sea level rise. The order directs the state's Business, Transportation and Housing Agency to assess the vulnerability of state transportation systems to sea level rise and directs the Governor's Office of Planning and Research (OPR) to provide state land-use planning guidance related to sea level rise and other climate change impacts.

Executive Order B-30-15

Signed by Governor Jerry Brown on April 29, 2015, Executive Order B-30-15 establishes a California GHG reduction target of 40 percent below 1990 levels by 2030.

Assembly Bill 32, California Global Warming Solutions Act of 2006

In September 2006, the California State Legislature adopted Assembly Bill 32, the California Global Warming Solutions Act of 2006 (AB 32). AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the California Air Resources Board (ARB) is required to take the following actions.

- Adopt early action measures to reduce GHGs.
- Establish a statewide GHG emissions cap for 2020 based on 1990 emissions.
- Adopt mandatory report rules for significant GHG sources.
- Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions.
- Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs.

California Climate Adaptation Strategy 2009 and 2013 Update

In 2009, California adopted a statewide Climate Adaptation Strategy (CAS). The CAS summarizes climate change impacts and recommends adaptation strategies for seven sectors: public health, biodiversity and habitat, oceans and coastal resources, water, agriculture, forestry, and transportation and energy (California Natural Resources Agency 2009). The California Natural Resources Agency is engaged in updating the CAS to augment strategies in light of advances in climate science.

California Renewables Portfolio Standard (California Senate Bill 1078 and 107)

Established in 2002 under Senate Bill (SB) 1078, and amendments thereto, the California Renewables Portfolio Standard (RPS) requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 33 percent of total procurement by 2020. The California Public Utilities “Commission and the California Energy Commission jointly implement the RPS program. SB 107 (2006) accelerated the RPS by requiring electric corporations to increase procurement from eligible renewable energy resources by at least 1 percent of their retail sales annually, until they reach 20 percent by 2010.

California Air Resources Board Climate Change Scoping Plan

The California Global Warming Solutions Act of 2006 (AB 32) required ARB to prepare and adopt a plan that identified measures that would achieve reductions in GHG emissions in the State. In 2008, the ARB first considered the Climate Change Scoping Plan and in 2014 approved the first update to the plan (Scoping Plan). In particular, the Scoping Plan contains six strategies or measures for the water sector to implement that are expected to reduce GHG emissions due to the fact that water use requires significant amounts of energy. The six strategies for the water sector to implement include Water Use Efficiency (Measure W-1), Water Recycling (Measure W-2), Water System Energy Efficiency (Measure W-3), Reuse Urban Runoff (Measure W-4), Increase Renewable Energy Production from Water (Measure W-5), and a Public Goods Charge (Measure W-6). Efficient water conveyance, treatment and use can result in reductions in GHG emissions for those activities. The implementation of Measures W-1 through W-5 is expected to result in a total reduction of 4.8 MMT of CO_2e by 2020. The 2014 update to the Scoping Plan provides a status update of each of the measures but did not change the measures. The State Water Board is a sponsor of climate mitigation measures in the Scoping Plan (State Water Board 2011).

CEQA Statutes and Guidelines

SB 97 of 2007 requires that the Governor's OPR prepare guidelines for adoption by the California Resources Agency (now California Natural Resources Agency) regarding mitigation of GHG emissions or the effects of GHG emissions as required by the California Environmental Quality Act (CEQA). The amendments became effective in 2010.

State CEQA Guidelines Section 15064.4 specifically address how to determine the significance of impacts from GHG emissions. Section 15064.4 calls for a good-faith effort to describe, calculate, or estimate GHG emissions resulting from a project. Section 15064.4 further states that an agency should include certain factors when assessing the significance of GHG emission impacts on the environment, including the extent to which the project would increase or reduce GHG emissions, exceed an applicable threshold of significance, and comply with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions. The revisions also state that a project may be found to have a less-than-significant impact if it complies with an adopted plan consistent with State CEQA Guidelines Section 15183.5 that includes specific measures to sufficiently reduce GHG emissions. (State CEQA Guidelines, § 15064.4, subd. (b)(3.) However, the revised guidelines do not require or recommend a specific analysis methodology or provide quantitative criteria for determining the significance of GHG emissions.

In order to assure that wise and efficient use of energy is considered in project decisions, CEQA requires that environmental impact reports (EIRs) include a discussion of the potential energy impacts of proposed projects, including identifying mitigation measures proposed to reduce inefficient, wasteful, and unnecessary consumption of energy. Appendix F of the State CEQA Guidelines also includes guidelines for evaluating potential energy impacts.

California Water Plan Update 2009 and 2013

The California Water Plan (CWP) is the long-term strategic plan for guiding the management and development of water resources in the state. Since its first publication in 1957, California Department of Water Resources (DWR) has prepared eight water plan updates (known as the Bulletin 160 series). The California Water Code requires that the CWP be updated every 5 years.

CWP Update 2009 incorporated climate change in water plan scenarios to evaluate impacts on California's water resources and to identify and recommend statewide and regional adaptation strategies (DWR 2010b). The State Water Board staff was actively engaged in preparation and review of sections of the CWP Plan Update 2009 (State Water Board 2011).

The CWP Update 2013 includes regionally appropriate and statewide water management and planning adaptation and mitigation strategies, resource management strategies, and decision support for climate change scenarios (California Natural Resources Agency and DWR 2013).

Progress on Incorporating Climate Change into Management of California's Water Resources (Technical Memorandum Report)

In response to Executive Order S-3-05 (described above), DWR developed this report, which describes progress made incorporating climate change into existing water resources planning and management tools and methodologies for California. This report focuses on assessment methodologies and preliminary study results and is primarily focused on the potential effects of climate change on the Central Valley and associated water resource systems (DWR 2010a).

Water Boards' Water Quality Control Plans and Strategic Plan

The State Water Board and Regional Water Quality Control Boards regularly review water quality control plans (WQCP). This planning process provides an opportunity to consider information related to water quality, such as developing information about climate change. The 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan) identifies climate change as an emerging issue to be addressed in the WQCP planning process. The *2008–2012 State Water Board Strategic Plan* also calls for consideration of climate change in several areas, including the planning process for WQCPs. Under climate change scenarios, it is likely that increased flow variability and shifts in timing of high flows would occur.

Water Conservation Bill of 2009 (SBX7-7)

In 2009, the Legislature enacted a water reform package that included requirements for urban water suppliers and agricultural water suppliers. The Urban Water Management Planning Act requires urban water suppliers to prepare urban water management plans, which must be updated every 5 years. The Agricultural Water Management Planning Act requires agricultural water suppliers to adopt agricultural management plans that describe the quality and quantity of water resources of the supplier, including an analysis of the effect of climate change on future water supplies. Agricultural water suppliers were required to prepare the agricultural water management plans (AWMPs) by December 2012, and update those plans by December 2015 and every 5 years thereafter.

14.3.3 Regional or Local

Relevant regional or local programs, policies, or regulations related to GHG emissions are described below. Although local policies, plans, and regulations are not binding on the State of California, below is a description of relevant ones.

San Joaquin Valley Air Pollution Control District

In December 2009, the San Joaquin Valley Air Pollution Control District (SJVAPCD) formally adopted the region's first GHG thresholds for determining significant climate change impacts in the SJVAPCD. The guidance is intended to streamline CEQA review by pre-quantifying emissions reductions that would be achieved through the implementation of Best Performance Standards (BPS). Projects are considered to have a less-than-significant cumulative impact on climate change if any of the following conditions are met.

1. Comply with an approved GHG reduction plan.
2. Achieve a score of at least 29[5] using any combination of approved operational BPS.
3. Reduce operational GHG emissions by at least 29 percent over business-as-usual (BAU) conditions (demonstrated quantitatively).

SJVAPCD guidance recommends quantification of GHG emissions for all projects in which an EIR is required, regardless of whether BPS achieve a score of 29 (SJVAPCD 2009a). While the thresholds adopted by the SJVAPCD were developed for internal use for projects in which the SJVAPCD is the lead agency, these thresholds also serve as the basis for guidance issued by the SJVAPCD for other agencies that are establishing their own processes for determining significance related to climate change (SJVAPCD 2009b).

Agricultural Water Management Plans

All irrigation districts within the plan area have adopted AWMPs and provided these to DWR as required by SBX7-7 (described in Section 14.3.2, *State [Regulatory Background]*). These plans all have sections that discuss the expected effects of climate change on agriculture within their districts and on the water supply used within the districts. Table 14-8 summarizes those effects and their associated action plans and recommendations as stated in the AWMPs.

Urban Water Management Plans

The municipal water providers within the plan area that receive surface water from the irrigation districts have all prepared urban water management plans (UWMPs) for their respective service areas as required by the California Urban Water Management Plan Act (described in Section 14.3.2, *State [Regulatory Background]*). These municipal water providers, described in Chapter 13, *Service Providers*, are: Stockton East Water District (SEWD); City and County of San Francisco (CCSF); City of Modesto and MID; Contra Costa Water District (Contra Costa WD); City of Manteca (City of Manteca); City of Stockton (Stockton); and City of Tracy (Tracy). Some of the providers' UWMPs have sections that discuss the expected effects of climate change on water demand within their service areas and on the water supply used within their service areas. Table 14-9 summarizes the climate-change related information presented in the UWMPs.

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[5] A score of 29 represents a 29 percent reduction in GHG emissions relative to unmitigated conditions (1 point = 1 percent). This goal is consistent with the reduction targets established by AB 32.

Table 14-8. Agricultural Water Management Plans and Climate Change

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
South San Joaquin Irrigation District (SSJID)	Yes	• Increased crop water demands due to increased temperatures and other climate change factors. • Increased irrigation requirements to meet increased evapotranspiration demands.	• Reduced total inflows to New Melones Reservoir would increase the probability that total inflows would be less than 600 TAF/y, which would result in supplies less than 300 TAF more often than predicted, based on historical data. • There would be no effect on SSJID's annual water supply allotment due to the shift in runoff to winter because SSJID's annual available supply under the 1988 Agreement (described in Chapter 2, *Water Resources*, Section 2.6.2, *Water Diversion and Use*) is based on total annual inflows to New Melones Reservoir.	• Increased erosion and turbidity would not likely significantly affect the water quality of the Stanislaus River. • Increased water temperatures could result in an increase in aquatic plants within SSJID's distribution system, which could pose challenges to filtering canal water for microirrigation. • There are no known contaminants that could be concentrated to levels that would affect agricultural irrigation if spring runoff decreases, particularly due to dilution in reservoirs upstream of SSJID.	• Implement climate change mitigation strategies identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); The California Natural Resources Agency and DWR 2013) and in the California Climate Adaptation Strategy (California Natural Resources Agency 2009), as needed.[a]

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Oakdale Irrigation District (OID)	Yes	• Increased irrigation requirements to meet increased evapotranspiration demands due to increased temperatures. • Increased crop water demands due to increased temperatures and other factors related to climate change. • Changes in the timing of crop planting, development, and harvest due to increased temperatures and other factors related to climate change could result in changes to the timing of irrigation demands during the year.	• The shift in runoff to the winter period could potentially affect surface water supply if sufficient storage is not available to retain winter runoff. Because OID's annual entitlement is based on total annual inflows to New Melones Reservoir, the timing of runoff would not affect OID's annual allotment. • Entitlements less than 300 TAF could occur more often than predicted (based on analysis of historical data) because future reduced total inflows to New Melones Reservoir would increase the probability that total inflows would be less than 600 TAF in any given year.	• Increased erosion and turbidity would not likely significantly affect the water quality of the Stanislaus River. • Increased water temperatures could result in increased algae and other water plant growth, which would pose challenges to filtering OID canal water for microirrigation. • There are no known contaminants that could be concentrated to levels that would affect agricultural irrigation if spring runoff decreases, particularly due to dilution in reservoirs upstream of OID.	• Implement climate change mitigation strategies identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); California Natural Resources Agency and DWR 2013) and in the California Climate Adaptation Strategy (California Natural Resources Agency 2009), as needed.[a]

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Turlock Irrigation District (TID)	Yes	• Increased crop evapotranspiration due to increased temperatures. • Increased crop water demands due to increased temperatures.	• The shift in runoff to the winter period and projected reduction in total runoff could potentially affect water supply in the future if sufficient storage is not available to retain winter runoff and provide additional carryover storage from wet to dry years.	• Increased erosion and turbidity would not likely significantly affect the water quality of the Tuolumne River.	• Implement climate change mitigation strategies identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); California Natural Resources Agency and DWR 2013)and in the California Climate Adaptation Strategy (California Natural Resources Agency 2009), as needed.[a]
Modesto Irrigation District (MID)	Yes	• Faster plant development, shorter growing seasons, increased evapotranspiration, and potential heat stress for some crops due to increased temperatures. • Increased crop water demands, particularly for fruit crops, due to increased air temperatures. • Increase in water demand. • Impacts on agriculture due to climate change are anticipated to be significant.	• Reduced average annual snowpack due to a rise in the snowline and thinner snowpack in low- and medium-elevation zones. • Changes in the timing, intensity, location, amount, and variability of precipitation, including a shift in snowmelt runoff to earlier in the year, and increased precipitation falling as rain instead of as snow. • Increase in evaporation will require additional water supply.	Not addressed	• Adaptive management of water. • Water conservation. • Improve operational control within MID.

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Merced Irrigation District (Merced ID)	Yes	• Faster plant development, shorter growing seasons, changes to reference evapotranspiration, and potential heat stress for some crops due to increased temperatures. • Fruit crops may require additional water as climate warms to maintain yield and quality. • Increased agricultural water demands due to increased temperatures and evapotranspiration rates. Increased fallow land and retired land acreage.	• Exacerbated groundwater overdraft due to increased demands on groundwater as a result of decreased surface flows. • Additional water storage would be required to ensure water supply reliability due to early spring runoff and a reduction in mean flow.	• Degraded surface and groundwater quality due to lower flows, groundwater overdraft, meadow reduction, and increased drought frequency and severity, and storm events.	• Implement resource management strategies for water management approaches in the region identified in the California Water Plan 2009 and 2013 Updates (DWR 2010b and 2013); California Natural Resources Agency and DWR 2013). • Augmenting crop water requirements by pumping groundwater, improving irrigation efficiency, and shifting to high-value and salt-tolerant crops in response to climate change

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Agricultural Water Demand	Potential Effects on Agricultural Water Supply	Potential Effects on Water Quality	Planning Recommendations or Actions
Stockton East Water District (SEWD)	Yes	Not addressed	• Water supply originating from the Stanislaus River could be affected by climate change because a significant portion of that surface water is derived from snow melt. Any decrease in snow melt resulting from climate change would have a significant impact on New Melones Dam storage. • A reduction in rainfall would affect water supply	Not addressed	• Although not specific to water shortages due to climate change, in response to water shortages, SEWD would implement an agricultural water shortage plan for dry year or drought conditions, which includes voluntary reductions in use the first dry year and second subsequent dry year, and potential mandatory reductions in the third subsequent dry year.

Sources: SSJID 2012; OID 2012; TID 2012; MID 2012; Merced ID 2013; SEWD 2014.

TAF/y = thousand acre-feet per year

[a] Many of the climate change mitigation strategies that are applicable to irrigation districts are currently being implemented in some form to meet local and regional water management objectives.

Table 14-9. Urban Water Management Plans and Climate Change

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Water Supply	Planning Recommendations or Actions
City of Stockton	Yes	• Water supply originating from the Stanislaus River could be affected by climate change because a significant portion of that surface water is derived from snow melt. Any decrease in snow melt resulting from climate change would have a significant impact on New Melones Dam storage. • A reduction in rainfall would affect water supply.	Although not specific to water shortages due to climate change, in response to a water shortage emergency, the City of Stockton would implement their five-stage rationing plan, which includes both voluntary (10 percent reduction) and mandatory (up to 20 percent in past years) reductions.
City and County of San Francisco	Yes	• A rise in temperature of 1.5°C between 2000 and 2025 would result in less or no snowpack between 6,000 and 6,500 feet (ft) and faster melting of the snowpack above 6,500 ft. • Approximately 7 percent of the runoff currently draining into Hetch Hetchy Reservoir would shift from spring/ summer to fall/winter in the Hetch Hetchy basin by 2025. This percentage is within the current interannual variation in runoff and is within the range accounted for during normal runoff forecasting and existing reservoir management practices.	Prepare climate change modeling and evaluation to inform risk-based decisions for the future and prepare a work plan for the SFPUC climate change assessment of Hetch Hetchy and local watersheds.
Contra Costa Water District	No	NA	NA
City of Manteca	No	NA	NA

Water Supplier	Evaluated Climate Change? (Yes/No)	Potential Effects on Water Supply	Planning Recommendations or Actions
City of Modesto and Modesto Irrigation District	Yes	• Reduced snowpack may shift spring runoff to earlier in the year.	• Implement a water conservation program (Section 11-1.14 of Title XI of the Modesto Municipal Code), including the completing the residential metering program to help reduce water demands and to conserve energy as a result of decreased treatment, conveyance, and pumping requirements. • The City of Modesto's compliance with SBx7-7 and its interim and final per capita water use targets will ensure continued water and energy conservation. • The City of Modesto's increased use of surface water supplies from MID's Modesto Regional Water Treatment Plant Phase Two will help to further diversify Modesto's water supplies and enhance water supply reliability to adapt to the changing hydrologic conditions associated with climate change.
City of Tracy	Yes	• Reduced snowpack may shift spring runoff to earlier in the year.	• For conservative planning/projection purposes, the City of Tracy has reduced the predicted available water supply to 75 percent of the city's Central Valley Project annual entitlement in a normal water year, and 65 percent in a single dry year.

Sources: City of Stockton 2011; SFPUC 2011; Contra Costa WD 2011; City of Manteca 2005; City of Modesto and MID 2011; and City of Tracy 2011.
NA = not applicable

14.4 Impact Analysis

This section identifies the thresholds or significance criteria used to evaluate the potential impacts on energy resources, GHG emissions and climate change. It further describes the methods of analysis used to determine significance. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, if any significant impacts are identified.

14.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based, in part, on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations (Cal. Code Regs., tit. 23, §§ 3720–3781) and Appendix F of the State CEQA Guidelines. The thresholds derived from the checklist have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) GHG impacts were determined to be potentially significant in the State Water Board's Environmental Checklist (see Appendix B, *State Water Board's Environmental Checklist*) and, therefore, are discussed in this analysis. In addition, this chapter evaluates impacts on energy resources, as recommended by Appendix F of the State CEQA Guidelines, and climate change, as recommended by Appendix G of the State CEQA Guidelines. Although Appendix G calls for a determination of the significance of GHG emissions (as opposed to climate change), *climate change* in this document refers to an assessment of GHG emissions per the guidelines and is used interchangeably in this analysis.

Energy Resources

Energy impacts would be significant if the LSJR alternatives result in any of the following.

- Adversely affect the reliability of California's electric grid.
- Result in inefficient, wasteful, and unnecessary energy consumption.

According to CEQA Appendix F, the goal of conserving energy implies the wise and efficient use of energy. In order to assure that energy implications are considered in project decisions, CEQA requires a discussion of the potential energy impacts of proposed projects and the impacts of avoiding or reducing inefficient, wasteful, and unnecessary consumption of energy.

GHG Emissions/Climate Change

Climate change impacts would be significant if the LSJR alternatives result in any of the following.

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.
- Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions.

Potential changes in electricity generation and distribution could occur; however, local air pollution control districts have not adopted GHG thresholds directly relevant to the alternatives to evaluate climate change impacts.[6] As there is no acceptable GHG reduction plan from which to evaluate project significance consistent with State CEQA Guidelines Sections 15183.5 and 16064.4(b)(3), and local air district thresholds are not directly applicable to the alternatives, a threshold of 10,000 MT of CO_2e per year is used for evaluating the GHG emission impact of the project under CEQA. The threshold of 10,000 MT of CO_2e per year was adopted by the South Coast Air Quality Management District (SCAQMD) and the Bay Area Air Quality Management District (BAAQMD) for industrial projects that would capture 90 percent of all GHG emissions from stationary sources in each air basin. Because the alternatives would affect facilities in several air pollution control districts, the GHG threshold, although conservative, would be appropriate measure to evaluate climate change impacts.

State CEQA Guidelines Section 15126.2(a) states that the CEQA analysis should analyze any significant impact the project might cause by bringing development and people into the area affected and should analyze any potentially significant impacts of locating a project in areas susceptible to hazardous conditions. The California Supreme Court has held that this provision is valid to the extent it calls for evaluating a project's potentially significant exacerbating effects on existing environmental hazards and that CEQA's provisions are best read to focus almost entirely on how the project affects the environment, not how the environment affects the project (*California Building Industry Association v. Bay Area Air Quality Management District* [2015] 62 Cal.4th 367). The alternatives do not involve environmental hazards. Nevertheless, the analysis presented below also evaluates how the LSJR and SDWQ alternatives may be affected by climate change.

14.4.2 Methods and Approach

LSJR Alternatives

This chapter evaluates the potential energy and GHG impacts associated with the LSJR alternatives. Each LSJR alternative includes a February–June unimpaired flow requirement (i.e., 20, 40, or 60 percent) and methods for adaptive implementation to reasonably protect fish and wildlife beneficial uses, as described in Chapter 3, *Alternatives Description*. In addition, a minimum base flow is required at Vernalis during this period. The base flow may be adaptively implemented as described below and in Chapter 3. State Water Board approval is required before any method can be implemented, as described in Appendix K, *Revised Water Quality Control Plan*. All methods may be implemented individually or in combination with other methods, may be applied differently to each tributary, and could be in effect for varying lengths of time, so long as the flows are coordinated to achieve beneficial results in the LSJR related to the protection of fish and wildlife beneficial uses.

The Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the flow objectives and with developing biological goals to help evaluate the effectiveness of the flow requirements and adaptive implementation actions. The STM Working Group may recommend adjusting the flow requirements through adaptive implementation if scientific information supports such changes to reasonably protect fish and wildlife beneficial uses. Scientific research may also be conducted within the adaptive range to improve scientific understanding of measures needed to protect fish and wildlife and reduce scientific uncertainty through monitoring and evaluation. Further details describing the

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[6] While the SJVPACD has established thresholds of significance for climate change impacts, there are no BPS that are directly applicable to the alternatives and the SJVAPCD's 29 percent reduction in GHG emissions is not directly applicable to the alternatives, as the alternatives would not have any direct control over GHG generating activities.

methods, the STM Working Group, and the approval process are included in Chapter 3 and Appendix K.

Without adaptive implementation, flow must be managed such that it tracks the daily unimpaired flow percentage based on a running average of 7 days. The four methods of adaptive implementation are described briefly below.

1. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the specified annual February–June minimum unimpaired flow requirement may be increased or decreased to a percentage within the ranges listed below. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.
2. Based on best available scientific information indicating a flow pattern different from what would occur by tracking the unimpaired flow percentage would better protect fish and wildlife beneficial uses, water may be released at varying rates during February–June. The total volume of water released under this adaptive method must be at least equal to the volume of water that would be released by tracking the unimpaired flow percentage from February–June.
3. Based on best available scientific information, release of a portion of the February–June unimpaired flow may be delayed until after June to prevent adverse effects to fisheries, including temperature, which would otherwise result from implementation of the February–June flow requirements. The ability to delay release of flow until after June is only allowed when the unimpaired flow requirement is greater than 30 percent. If the requirement is greater than 30 percent but less than 40 percent, the amount of flow that may be released after June is limited to the portion of the unimpaired flow requirement over 30 percent. For example, if the flow requirement is 35 percent, 5 percent may be released after June. If the requirement is 40 percent or greater, then 25 percent of the total volume of the flow requirement may be released after June. As an example, if the requirement is 50 percent, at least 37.5 percent unimpaired flow must be released in February–June and up to 12.5 percent unimpaired flow may be released after June. If after June the STM Working Group determines that conditions have changed such that water held for release after June should not be released by the fall of that year, the water may be held until the following year. See Chapter 3 and Appendix K for further details.
4. Based on best available scientific information indicating that more flow is needed or less flow is adequate to reasonably protect fish and wildlife beneficial uses, the February–June Vernalis base flow requirement of 1,000 cfs may be modified to a rate between 800 and 1,200 cfs.

The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or longer-term basis. Adaptive implementation is intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. While the measures and processes used to decide upon adaptive implementation actions must achieve the narrative objective for the reasonable protection of fish and wildlife beneficial uses, adaptive implementation could result in flows that would benefit or reduce impacts on other beneficial uses that rely on water. For example, terrestrial riparian species could benefit by receiving additional flows during key germination times in the late spring.

The quantitative results included in the figures, tables, and text of this chapter present Water Supply Effects (WSE) modeling of the specified unimpaired flow requirement for each LSJR alternative (i.e., 20, 40, or 60 percent). The modeling does allow some inflows to be retained in the reservoirs after June, as could occur under adaptive implementation method 3, to prevent adverse temperature effects and this is included in the results presented in this chapter. This use of modeling provides information to support the analysis and evaluation of the effects of the alternatives and adaptive implementation. For more information regarding the modeling methodology and quantitative flow and temperature modeling results, see Appendix F.1, *Hydrologic and Water Quality Modeling*.

However, as part of adaptive implementation, method 1 would allow the required percent of unimpaired flow to change by up to 10 percent if the STM Working Group agrees to adjust it. The highest possible percent of unimpaired flow associated with an LSJR alternative is also evaluated in the impact analysis if long-term implementation of method 1 has the potential to affect a significance determination. For example, if the determination for LSJR Alternative 2 at 20 percent unimpaired flow is less than significant, but the determination for LSJR Alternative 3 at 40 percent unimpaired flow is significant, then LSJR Alternative 2 is also evaluated at the 30 percent unimpaired flow.

Reduction in Hydropower Production

This section summarizes the method to estimate the potential reduction in hydropower generated by power plants on the three eastside tributaries as a result of the LSJR alternatives. Detailed information related to this methodology is in Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*. The method relies on the WSE model to estimate the effects of the LSJR alternatives on reservoir releases and storage (elevations head) and allowable diversions to off-stream generation facilities, and then calculate the associated change in monthly and annual amounts of energy produced in comparison to the baseline model run. Specific details of the LSJR alternatives are provided in Chapter 3, *Alternatives Description*, and are the basis for how the alternatives are modeled in this analysis.

Hydropower facilities on the three eastside tributaries were grouped into four categories (in-stream, rim dam, off-stream, and upstream), based on where they are located relative to the three eastside tributary dams and whether they are in-stream facilities or off-stream facilities.

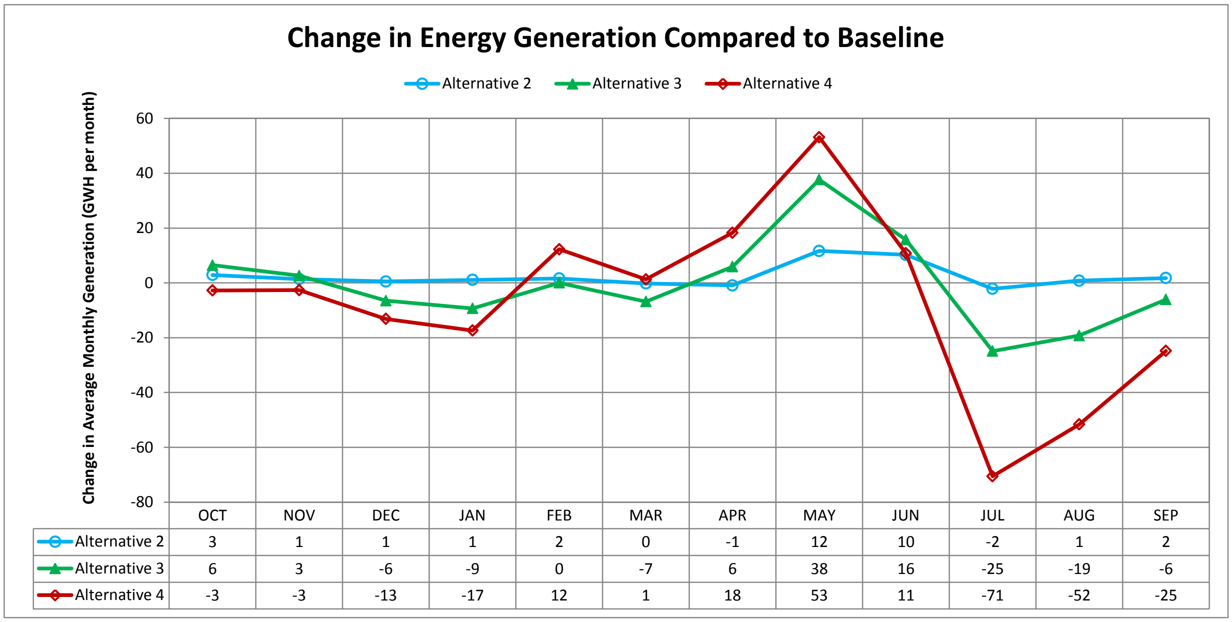
Detailed discussions on calculating hydropower from each of the categories are provided in Appendix J. Table 14-10 contains a summary of the average annual hydropower generation change on each of the three eastside tributaries due to LSJR Alternatives 2, 3, and 4. These changes are also represented as a percent of baseline generation. Generally, as the percent unimpaired flow increases, the amount of power generated annually is reduced. Overall, hydropower generation is expected to increase with LSJR Alternative 2, remain about the same with LSJR Alternative 3, and decrease with LSJR Alternative 4 relative to baseline.

Table 14-10. Change in Average Annual Hydropower Generation from Baseline

Alternative		Stanislaus River (GWh)/(%)	Tuolumne River (GWh)/(%)	Merced River (GWh)/(%)	Plan-wide Total (GWh)/(%)
	Baseline Conditions Power Generation	586 (100)	656 (100)	408 (100)	1,650 (100)
	Change of Hydropower Generation (Alternative minus Baseline)				
LSJR Alternative 2	20% Unimpaired Flow	18 (3)[a]	2 (0)	8 (2)	29 (2)
	Adaptive Implementation Method 1: 30% Unimpaired Flow	11 (2)	0 (0)	4 (1)	15 (1)
LSJR Alternative 3		4 (1)	-6 (-1)	-3 (-1)	-4 (0)
LSJR Alternative 4		-23 (-4)	-41 (-6)	-23 (-6)	-87 (-5)

Source: Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*.
GWh = gigawatt hours
[a] Modeled results indicate that LSJR Alternative 2 would result in an increase in hydropower production.

The monthly pattern of the average change (over 82 years of simulation) in hydropower generation from the plan area when compared to the baseline condition is presented in Figure 14-4. This shows a general increase in energy production in the months of February–June as more flow would be released from the reservoirs to meet the unimpaired flow objectives. For LSJR Alternatives 3 and 4, a decrease in hydropower generation during the summer months of July–September is due to less water being released from the major reservoirs as a result of reduced diversions downstream, as well as lower reservoir elevations. During November–January, a decrease in hydropower generation associated with LSJR Alternatives 3 and 4 is related to lower reservoir elevations and a reduced need for flood control releases. These effects are more pronounced as the percentage of unimpaired flow requirement of the LSJR alternatives increases.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alternative 2	3	1	1	1	2	0	-1	12	10	-2	1	2
Alternative 3	6	3	-6	-9	0	-7	6	38	16	-25	-19	-6
Alternative 4	-3	-3	-13	-17	12	1	18	53	11	-71	-52	-25

Figure 14-4. Change in Average Monthly Hydropower Generation across 82 Years of Simulation Associated with the LSJR Flow Alternatives Compared to Baseline

Power Flow Assessment

The LSJR alternatives could reduce the hydropower generation in the summer months of July–September because less water would be stored during those months in the reservoirs as a result of being released earlier in the year (e.g., February–June), thereby reducing the amount of water available for hydropower generation. Since California's electric grid is most stressed during the summer months of June–August, with peak demand typically occurring in the month of July, a reduction in hydropower capacity during this time has the potential of stressing the grid even further.

The results of a steady-state power flow assessment of the California grid are used to determine if reduction in hydropower capacities at New Melones, New Don Pedro, and New Exchequer power plants would adversely impact the grid reliability as defined by NERC (see Appendix J, *Hydropower and Electric Grid Analysis of LSJR Flow Alternatives*, for discussion of NERC reliability). The reduction in hydropower capacity at the three power plants was calculated using the WSE model for the month of July during the 82-year period (water years 1922–2003) for LSJR Alternatives 2, 3, and 4. July was chosen because it is a peak energy-use month and, therefore, has some of the largest hydropower capacity effects. Detailed discussions on the capacity reduction calculation are presented in Appendix J. LSJR Alternative 2 would lead to no power capacity reduction from the baseline condition and, therefore, is not considered further in this analysis. The power flow assessment was conducted for LSJR Alternatives 3 and 4, assuming a reduction in capacity of 5 percent and 8 percent, respectively (slightly greater impacts than what was estimated with the WSE model, as described in Appendix J).

Detailed discussions of the power assessment are presented in Appendix J. In summary, the study examined the operation of the electric grid under peak summer demand conditions, using the following steps.

- Develop a baseline case and separate change cases for LSJR Alternatives 3 and 4. All cases are developed for both normal and contingency conditions. Under normal conditions, all transmission and generator facilities are assumed to be in service. Contingency conditions refer to the unplanned outage of power system equipment.
- Select analysis contingency conditions for transmission and generator facilities.
- Select the analysis areas based on the transmission line/transformer loadings and substation voltages.
- Model the transmission line/transformer loadings and substation voltages for baseline and LSJR Alternatives 3 and 4 under both normal and contingency conditions.
- Determine the impact of LSJR Alternatives 3 and 4 on the reliability of California's electric grid by comparing the analysis results to baseline.

If the comparison showed that transmission line/transformer loadings or substation voltages are within violation limits in baseline, but outside the limits in LSJR Alternatives 3 and 4, the alternatives could be considered to have an adverse impact on the reliability of California's electric grid.

Generally, a well operated transmission system should have line flows that are within the ratings of the transmission lines and substation voltages that are close to the nominal voltages. Typically, transmission lines have normal and emergency ratings. The analysis uses the normal and long-term emergency ratings (LTE) for the normal and contingency analyses, respectively.

Voltage limits were established relative to the nominal voltages. Under normal conditions, system operators regulate nodal voltages within ±5 percent of their nominal values. Under contingency conditions, this limit is relaxed to ±10 percent of the nominal value. These limits are typically set by the transmission owning utilities and the grid operator. When voltages or line loadings deviate from these limits it is referred to as a reliability violation. The limits used in the study for transmission line/transformer loading were the normal and LTE ratings. Under the normal conditions, transmission line/transformer flows should remain within the normal ratings. Under contingency conditions, transmission line/transformer flows should remain within the LTE ratings. Under normal conditions, substation voltages should remain within ±5 percent limit of the voltages of their nominal values. Under contingency conditions, the substation voltages should remain within ±10 percent limit of the nominal values.

The results of the power flow analysis for LSJR Alternatives 3 and 4 are presented in detail in Appendix J and are summarized below. These results are used to determine significant impacts on California's power grid.

- Under normal operating conditions, neither LSJR Alternatives 3 nor 4 triggered any transmission line or transformer to violate the normal and LTE ratings.
- Under contingency conditions, no line/transformer limit violation was found for LSJR Alternative 3. However, under LSJR Alternative 4, the 230 kV line between Borden and Gregg substations showed a minor violation under the outage of the 230 kV line between Gregg and Storey substations. A re-dispatch of the three Helms generator units (Helms Unit 1, 2, and 3) reduced the minor violation. The new loading of the analysis element after this re-dispatch was 99.81 percent.

- No line/transformer limit violations were found that could be exclusively attributed to LSJR Alternatives 3 or 4 under generator contingencies.
- No voltage violations were found that could be exclusively attributed to the reduced hydropower capacity in LSJR Alternatives 3 or 4.

Increase in Energy Consumption

As described in Chapter 5, *Surface Hydrology and Water Quality*, the LSJR alternatives are expected to change annual water supply from the Stanislaus, Tuolumne, and Merced Rivers. To satisfy the existing water demand for the purpose of identifying energy and climate change impacts, it is assumed that the reduced water supply would be partially compensated by pumping groundwater by the end users. Increases in groundwater pumping associated with LSJR Alternatives 2, 3, and 4 were estimated as described in Chapter 9, *Groundwater Resources*. It was assumed that in times of shortage of surface water supply, the irrigation districts could increase groundwater pumping up to their maximum capacity based on 2009 (baseline) infrastructure. The assumption of partial replacement creates a realistic scenario for energy impacts. Table 14-11 summarizes the increase in average annual groundwater pumping estimated for each of the three eastside tributaries for LSJR Alternatives 2, 3, and 4.

To estimate energy impacts, it is assumed that the compensated pumping would be electric, and the electricity consumption for groundwater pumping is calculated using the rate of 478 kilowatt hours (kWh) per acre-feet (AF). The rate is based on a conservative assumption that the groundwater is at a uniform 189-foot depth (Burt 2011). Table 14-12 summarizes the increased annual electricity consumption for groundwater pumping, while Table 14-13 summarizes annual energy consumption in the service area of the LSJR and three eastside tributaries. It is anticipated that most deep wells are and would be powered by electric pumps, while a smaller portion will be powered by diesel generators. It is currently unknown what proportion of ground water pumping at deep wells would use electric- or diesel-powered pumps because it is unknown exactly which existing wells would pump more under the LSJR alternatives. Electric pumps are more efficient than diesel pumps and produce fewer emissions per unit of power. It is anticipated that, given the same horsepower rating, an electric pump would generate less than 3 percent of the GHG emissions than a diesel pump would (Leib 2012).Therefore, it was assumed groundwater wells would be powered by electric pumps.

Table 14-11. Increase in Estimated Average Annual Groundwater Pumping by the Irrigation Districts Relative to Baseline (TAF/y)

Alternative		Stanislaus River	Tuolumne River	Merced River	Total
	Baseline Groundwater Pumping	91	103	69	262
	Change in Groundwater Pumping (Alternative minus Existing)				
LSJR Alternative 2	20% Unimpaired Flow	-3	1	25	23
	Adaptive Implementation Method 1: 30% Unimpaired Flow	4	9	26	40
LSJR Alternative 3		26	18	64	109
LSJR Alternative 4		75	34	116	224

Source: Derived from information in Chapter 9, *Groundwater Resources*, and Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results* (Table G.3-3).
TAF/y = thousand acre-feet per year

Table 14-12. Increase in Electricity Consumption for Groundwater Pumping

Alternative		Stanislaus River (GWh)	Tuolumne River (GWh)	Merced River (GWh)	Project-wide Total (GWh)
LSJR Alternative 2	20% Unimpaired Flow	-1	1	12	11
	Adaptive Implementation Method 1: 30% Unimpaired Flow	2	4	13	19
LSJR Alternative 3		13	9	31	52
LSJR Alternative 4		36	16	55	107

GWh = gigawatt hours

Table 14-13. 2010 Annual Electricity Consumption in San Joaquin, Stanislaus, and Merced Counties

	2010 Annual Electricity Consumption by County (GWh)		
Sector	San Joaquin	Stanislaus	Merced
Non-Residential	3,879	2,971	2,962
Residential	1,682	1,634	660
County-Wide Total	5,561	4,505	3,622
Plan Area Total		13,688	

Source: CEC 2012.
GWh = gigawatt hours

GHG Emissions

The majority of the GHGs generated under the LSJR alternatives would result from the increase in power generation and energy consumption, which are described below.

Power Generation to Offset the Reduced Hydropower Production

LSJR alternatives 3 and 4, overall, would cause a reduction in annual hydropower production (although the change associated with LSJR Alternative 3 would be minimal). Table 14-10 summarized the reduction of average annual hydropower produced by each of the three eastside tributaries for LSJR Alternatives 2, 3, and 4 in comparison to the baseline hydropower production. To maintain the power supply for the end users, the lost hydropower would need to be compensated by ramping up other generation facilities by the following providers: PG&E, MID, TID, and Merced ID. The analysis of climate change impacts includes an analysis of GHG emissions associated with other generation facilities to offset the lost hydropower generation associated with the alternatives. The direct GHG emissions generated from the electricity produced by the other offsetting facilities are calculated using the CO_2 emission factor published in the 2008 TID Annual Emissions Report[7] (CCAR 2009) and the CH_4 and N_2O emission factors published by USEPA (2015b). Table 14-14 lists the emission factors for CO_2, CH_4, and N_2O used to estimate GHG emissions associated with offset power generation. These emission factors are multiplied by the change in electricity generation indicated in Table 14-10 and Table 14-11 to determine the change in GHG emissions associated with the project.

Table 14-14. Greenhouse Gas Emission Factors (lb/MWh)

Area	CO_2	CH_4	N_2O
Turlock Irrigation District Service Areas	790.00[a]	0.03112[b]	0.00567[b]
California Region[c]	650.31	0.03112	0.00567

Sources: [a] CCAR 2009; [b] No CH_4 or N_2O emission factors were reported by CCAR 2009. The emission factors published by USEPA are used (USEPA 2015b); [c] USEPA 2015b.

lb/MWh = pounds per megawatt hour
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide

Energy Consumption from Potential Increase in Groundwater Pumping

As shown in Table 14-11, some of the LSJR alternatives would result in an increase in groundwater pumping to satisfy the existing water demand, which could cause an increase in electricity consumption for pumping. Because it is unknown what specific energy providers supply affected end users, the GHG emissions generated from the electricity consumption for the groundwater pumping were calculated by multiplying the GHG factors published by USEPA (2015b) for the California region to represent an average or composite rate of emissions (Table 14-15) by the change in electricity generation indicated in Table 14-10 and Table 14-11.

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[7] The California Climate Action Registry (CCAR) does not have published emission factors for MID or Merced ID. While PG&E represents a larger service area than Turlock ID, the emission factor associated with Turlock ID was used in the emissions calculations, as it is larger than the PG&E emission factor and represent a worst-case estimate of the maximum amount of emissions that could be anticipated to result from the project.

The decrease in water available for cropland irrigation could result in a decrease in the acreage of cropland that would be farmed if groundwater pumping did not occur. It is anticipated that some croplands would be removed from active agricultural production; however, this would have the potential to reduce GHG emissions as these lands would no longer require the use of fertilizers, which are a major source of GHG emissions. In addition, fallowed agricultural lands would not require the use of agricultural machinery, which would also reduce emissions of GHGs. Fallow lands would be expected to retain crop stubble cover and would ultimately experience vegetative regrowth, which could result in a net carbon sequestration.

Table 14-15. Estimated Annual Greenhouse Gas Emissions (MT CO_2e/year)

Alternative		GHGs from Power Generation (to compensate for loss of hydropower)	GHGs from Energy Consumption (to compensate for increased groundwater pumping)	Total GHG Emissions
Baseline Conditions		0	0	0
LSJR Alternative 2	20% Unimpaired Flow	-10,342[a]	3,267	-7,075
	Adaptive Implementation Method 1: 30% Unimpaired Flow	-5,280	5,609	330
LSJR Alternative 3		1,541	15,408	16,948
LSJR Alternative 4		31,285	31,698	62,984

MT CO_2e/year = metric ton carbon dioxide equivalent per year

[a] Modeled results indicate that LSJR Alternative 2 would result in an increase in hydropower production.

However, changes to land use as a result of a decrease in water available for cropland irrigation are considered speculative. The population growth rate, the available water supply, the timing, and alternatives to replace the cropland are uncertain. Consequently, the GHG emission reduction resulting from land use changes were not included in the analysis.

Energy Consumption from Potential Change in Exports

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling*, the expected inflow from the LSJR could modify the CVP and SWP exports such that exports are expected to either remain the same or increase. The analysis related to exports and outflow assumes the State Water Board does not change export constraints to protect any increased flows downstream of Vernalis. The State Water Board is currently in the process of reviewing the export restrictions included in the 2006 Bay-Delta Plan as part of its periodic review of the plan. Through that process, the State Water Board will determine what changes, if any, should be made to the export restrictions. The State Water Board will then determine what actions are needed to implement changes to the flow and export objectives. As indicated in the program of implementation, the State Water Board plans to take action to protect the additional flows in future proceedings. As such the potential increase in exports is likely overstated in this analysis but is evaluated to provide a worst case analysis of the potential impacts related to additional exports.

Modeling results presented in Chapter 5 (Table 5-21) and Appendix F.1 (Table F.1.7-2b) indicate annual average exports would increase by 1 percent for LSJR Alternative 3 and 4 percent for LSJR Alternative 4 relative to historic conditions. It is appropriate to use the annual average when considering GHG emissions because GHG emissions are calculated and reported on an annual basis per standard inventorying procedures (e.g., IPCC, USEP). The extent to which a net increase in GHG emissions would occur cannot be quantified. This is because it is currently unknown how increased exports[8] would specifically affect other GHG emission producing activities in the CVP and SWP export service areas (e.g., groundwater pumping) or other energy-intensive water supply activities, such as drinking water treatment or transport. Because the change in groundwater pumping due to increased water exportation cannot be estimated, the net change in GHG emissions associated with water exports (i.e., emissions associated with exports and other activities that could be influenced by changes in exports) cannot be fully quantified. Therefore, impacts associated with a change in exports are discussed qualitatively for each of the LSJR alternatives.

Extended Plan Area

The analysis of the extended plan area generally identifies how the impacts may be similar to or different from the impacts in the plan area (i.e., downstream of the rim dams) depending on the similarity of the impact mechanism (e.g., changes in reservoir levels, reduced water diversions, and additional flow in the rivers) or location of potential impacts in the extended plan area. Where appropriate, the program of implementation is discussed to help contextualize the potential impacts in the extended plan area.

SDWQ Alternatives

As stated in Appendix B, *State Board's Environmental Checklist*, Section VII, the general historical range of salinity in the southern Delta would remain unchanged under the SDWQ alternatives (see also Chapter 5, *Surface Hydrology and Water Quality*) and, thus, would not result in GHG emissions or conflict with an applicable plan, policy or regulation adopted for the purpose of reducing GHG emissions. For the same reason, there would be no impacts related to the reliability of the electric grid or inefficient, wasteful and unnecessary energy consumption. Therefore, the SDWQ alternatives are not further analyzed in this chapter, except as they relate to the effect of climate change on the alternatives (EG-5). SDWQ Alternative 2 could result in service providers having to construct and operate new or expanded wastewater treatment or water supply facilities, which would involve changes in energy consumption and GHG emissions, and is evaluated in Chapter 13, *Service Providers*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

14.4.3 Impacts and Mitigation Measures

Energy Resources

This section evaluates the impact of LSJR alternatives on energy sources. The LSJR alternatives would affect energy by potentially reducing the power production at hydropower facilities along the three eastside tributaries.

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[8] Changes in water exports could influence GHG emissions as increases or decreases in exported water could lead to changes in GHG-generating activities (e.g., groundwater pumping, water transport, water treatment) that would accommodate the changes in water export.

Impact EG-1: Adversely affect the reliability of California's electric grid

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Based on the analysis approach described in Section 14.4.2, *Methods and Approach*, LSJR Alternative 2 would lead to no power capacity reduction for the three hydropower plants. For LSJR Alternatives 3 and 4, grid reliability was assessed by assuming a 5 percent and 8 percent reduction in July hydropower capacity, respectively, at the three plants.

The LSJR alternative substation voltages and line/transformer loadings were modeled and then compared with those of the baseline. If the comparison showed that substation voltages or transmission line/transformer loadings are within limits (defined in Section 14.4.2) under baseline, but outside the limits in the LSJR alternatives, the alternatives could be considered to have an adverse impact on the reliability of California's electric grid.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

Based on the analysis approach described in Section 14.4.2, *Methods and Approach*, LSJR Alternative 2, with or without adaptive implementation, would lead to no power capacity reduction from baseline. Therefore, this alternative is not expected to affect the reliability of California's electric grid. The impact would be less than significant.

LSJR Alternative 3 (Less than significant/Less than significant with adaptive implementation)

As described above, by comparing the results of LSJR Alternative 3 to baseline, LSJR Alternative 3, with or without adaptive implementation, would not result in any violations of line/transformer limits and substation voltage limits under normal and contingency conditions. Therefore, this alternative is not expected to affect the reliability of California's electric grid. The impact would be less than significant.

LSJR Alternative 4 (Less than significant/Less than significant with adaptive implementation)

As described above, LSJR Alternative 4, specifically the high unimpaired flow requirement of 60 percent of unimpaired flow, could adversely impact the reliability of California's electric grid because of minor violations between Borden and Gregg substations and Gregg and Storey substations. However, the results indicate that a simple re-dispatch of generator facilities would correct the minor violation. This violation of transmission line limit under the contingency outage condition can be easily eliminated through a re-dispatch of the three Helms generator units (Helms Units 1, 2, and 3). The new loading of the analysis element after this re-dispatch was

99.81 percent of the LTE rating. Therefore, there would be no violation after the re-dispatch. Re-dispatches are regular occurrences in the California energy grid and they provide a solution to re-distribute power based on the re-dispatch. Under the various adaptive implementation methods, it is anticipated the re-dispatch would not be needed or would be less given the unimpaired flow requirement is less (i.e., 50 percent unimpaired flow). Therefore, impacts would be less than significant.

Impact EG-2: Result in inefficient, wasteful, and unnecessary energy consumption

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project* Alternative (LSJR Alternative 1 and SDWQ Alternative 1), for the No Project Alternative technical analysis.

LSJR Alternatives

LSJR Alternatives 2, 3, and 4 (Less than significant/Less than significant with adaptive implementation)

Although LSJR Alternatives 2, 3, and 4, with or without adaptive implementation, could result in additional energy consumption by potentially increasing groundwater pumping as shown in Table 14-12, they would not result in inefficient, wasteful, and unnecessary consumption of energy. This is because any additional groundwater pumping would be used to meet the water supply irrigation demand.

Even under the conservative estimates used to project energy consumption associated with a potential increase in groundwater pumping, the LSJR alternatives would only increase the consumption by 0.08 percent (11 GWh), 0.38 percent (52 GWh), and 0.78 percent (107 GWh) under the LSJR Alternatives 2, 3, and 4, respectively, compared to the total annual electricity consumption in San Joaquin, Stanislaus, and Merced Counties (Table 14-13).

In addition to increased energy consumption associated with increased groundwater pumping, the LSJR alternatives could result in additional energy generation at other facilities to compensate for the loss of hydropower predicted by the model results, as shown in Table 14-10. However, by itself, this increased electricity generation is not considered inefficient, wasteful, and unnecessary, as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. LSJR Alternatives 2 and 3 are not expected to cause an overall reduction in hydropower generation. LSJR Alternative 4 would only reduce hydropower generation by 5 percent (87 GWh) compared to baseline. Modeled results indicate that LSJR Alternative 2 would result in an increase in hydropower production by 2 percent (29 GWh), and that LSJR Alternative 3 would result in minimal (4 GWh) change in hydropower production compared to baseline.

Therefore, none of the alternatives, with or without adaptive implementation, result in an inefficient, wasteful, or unnecessary consumption of energy, and none are anticipated to have a significant impact on the energy resources or supplies of the plan area. The impact would be less than significant.

GHG Emissions/Climate Change

This section evaluates the impact of LSJR alternatives on generation of GHG emissions and climate change. The LSJR alternatives would affect GHG emissions by potentially reducing the power production at hydropower facilities along the three eastside tributaries and by potentially reducing surface water supply. The State Water Board is committed to the adoption and implementation of effective actions to mitigate GHG emissions and adaptation of our policies and programs to the environmental conditions resulting from climate change. The State Water Board is a member of the Cal/EPA Climate Action Team, the Water Working Group of Climate Adaptation Strategies Team, and the 20x2020 Agency Team (State Water Board 2011).

Impact EG-3: Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Table 14-15 summarizes the annual GHG emissions generated from (1) the increased power generation at other generation facilities to balance the loss of hydropower production, and (2) the increased energy consumption for groundwater pumping to compensate for the reduction of surface water supply. The total GHG emissions generated by LSJR Alternatives 2, 3, and 4 are compared against the significance threshold of 10,000 MT CO_2e per year to determine the LSJR alternatives' impacts on climate change.

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

As shown in Table 14-15, GHG emissions (7,075 MT CO_2e/year) are expected to be reduced under LSJR Alternative 2. This is because the increase in hydropower production is anticipated to result in a decrease in power production from other power generation facilities, which reduces GHG emissions. This decrease in emissions outweighs the increase in GHG emissions from the increased energy consumption for groundwater pumping. Furthermore, as identified in Table F.1.7-2b, the average annual exports are not expected to change from baseline under LSJR Alternative 2. Therefore, impacts would be less than significant.

Adaptive Implementation

Based on best available scientific information indicating that a change in the percent of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 1 would allow an increase of up to 10 percent over the 20-percent February–June unimpaired flow requirement (to a maximum of 30 percent of unimpaired flow). A change to the percent of unimpaired flow would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.*

Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. However, an increase of up to 30 percent of unimpaired flow would potentially result in different effects as compared to 20-percent unimpaired flow, depending upon flow conditions and frequency of the adjustment. If the adjustment occurs frequently or for extended durations, impacts under LSJR Alternative 2 could become more like the impacts under LSJR Alternative 3. At the 30 percent unimpaired flow level, average annual total hydropower generation would be similar to baseline (i.e., slightly less than at the 20 percent unimpaired flow level, Table 14-10) but groundwater pumping would increase by an average total of 40 thousand acre-feet per year (TAF/y) relative to baseline (17 TAF/y more than LSJR Alternative 2, Table 14-11). The net effect is an increase in the average annual GHG emissions of 330 MT CO_2e/year (Table 14-15), which is less than the GHG threshold of 10,000 MT CO_2e/year. Consequently, LSJR Alternative 2, with the incorporation of adaptive implementation method 1, would not substantially impact GHG emissions.

Based on best available scientific information indicating that a change in the timing or rate of unimpaired flow is needed to reasonably protect fish and wildlife, adaptive implementation method 2 would allow changing the timing of the release of the volume of water within the February–June time frame. While the total volume of water released February–June would be the same as LSJR Alternative 2 without adaptive implementation, the rate could vary from the actual (7-day running average) unimpaired flow rate. Method 2 would not authorize a reduction in flows required by other agencies or through other processes, which are incorporated in the modeling of baseline conditions. A change in the timing of the flow releases would not affect diversions or groundwater pumping, and on average it would have little effect on hydropower generation. Therefore, method 2 would not substantially affect GHG emissions. Method 3 would not be authorized under LSJR Alternative 2 since the unimpaired flow percentage would not exceed 30 percent. Adaptive implementation method 4 would allow an adjustment of the Vernalis February–June flow requirement. WSE model results indicate changes due to method 4 under this alternative would rarely alter the flows in the three eastside tributaries or the LSJR, and thus would not affect GHG emissions.

Consequently the impact determination would be the same as described above for LSJR Alternative 2 and would not substantially increase GHG emissions. Impacts would be less than significant.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As shown in Table 14-15, GHG emissions (16,948 MT CO_2e/year) would exceed the GHG threshold of 10,000 MT CO_2e/year and impacts would be significant. Most of this increase (15,408 MT CO2e/year) would come from the predicted increase in groundwater pumping.

As discussed in Section 14.4.2, *Methods and Approach*, the annual average of water exports is expected to increase approximately 1 percent under LSJR Alternative 3 relative to historic export levels. While it is anticipated that this slight increase in water exports would result in a slight increase in the electricity consumption and associated GHG emissions, it is also expected that other water supply activities that may currently generate GHG emissions would be reduced as a result of the slight increase in exports. For example, an increase in water exports would be expected to lead to decreases in groundwater pumping, although the amount by which groundwater pumping would decrease cannot be quantified. In addition, other more energy-intensive means of water transport associated with water supply may decrease if water purveyors use slightly more exported water, depending on economic conditions, because it is less energy intensive. For example, if energy resources currently used to treat a local water supply rise such that treatment and distribution of the local supply is less cost effective than relying on imported water and the treatment is more energy intensive than relying on exported water, then using exported water could reduce cost and reduce energy use. Therefore, it is anticipated the modeled increase in exports would not contribute to a significant increase in GHG emissions.

A substitute environmental document (SED) must identify feasible mitigation measures for each significant environmental impact identified in it. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) A review of GHG mitigation measure guidance documents was conducted to determine if additional actions could be taken to reduce GHGs. These documents include: California Air Resources Board *Climate Change Scoping Plan* (ARB 2008), which was incorporated into the State Water Board's GHG guidance (State Water Board 2009); DWR Draft *Climate Action Plan* (DWR 2012), the Office of the Attorney General (OAG) list of proposed project-level GHG Mitigation Measures (OAG 2010); the California Air Pollution Control Officers Association (CAPCOA) *Quantifying Greenhouse Gas Mitigation Measures* report (CAPCOA 2010); and a number of reports from the USEPA, including the *Water Conservation Plan Guidelines* document (USEPA 1998), the *Control and Mitigation of Drinking Water Losses in Distribution Systems* report (USEPA 2010), the *Energy Management Guidebook for Wastewater and Water Utilities* (USEPA 2008), and the *Energy Efficiency in Water and Wastewater Facilities* report (USEPA 2013). In addition, Federal Energy Regulatory Commission (FERC) pre-application documents were reviewed. Example measures from these documents are listed below.

- Increase water system energy efficiency to reduce energy consumption related to irrigation deliveries (State Water Board 2009).
- Increase water use efficiency to reduce water demand related to agricultural uses (State Water Board 2009).
- Create water-efficient landscapes (e.g., by reducing lawn sizes; planting vegetation with minimal water needs, such as California native species; choosing vegetation appropriate for the climate of the project site; and choosing complementary plants with similar water needs or the ability to provide each other with shade and/or water) (OAG 2010; CAPCOA 2010).
- Reduce turf in landscapes and lawns (CAPCOA 2010).
- Install water-efficient irrigation systems and devices, such as soil moisture-based irrigation controls (OAG 2010).
- Devise a comprehensive water conservation strategy appropriate for the project and location. The strategy may include many of the specific items listed above, plus other innovative measures that are appropriate to the specific project (OAG 2010).
- Implement integrated resource management on both the supply-side (such as source-water protection strategies to conserve water resources and avoid costly new supplies) and the demand-side (such as comprehensive end-use audits) (USEPA 1998).
- Provide education about water conservation, such as through an "informative" water bill (OAG 2010; USEPA 1998).
- Increase energy efficiency of pumps and turbines throughout the SWP system through design, construction, and refurbishment methods (OP-2 Energy Efficiency Improvements) (DWR 2012).

- Improve efficiency of water system operations, such as by installing Supervisory Control and Data Acquisition (SCADA) software, which can increase the efficiency of process monitoring and operating control (USEPA 2013).
- Increase the proportion of energy used to run the SWP with energy supplies from renewable sources (OP 3 Renewable Energy Procurement Plan) (DWR 2012).
- Implement environmental restoration activities that have the potential to improve sequestration of carbon by natural processes (OP-6 Carbon Sequestration Actions) (DWR 2012).
- Use reclaimed water instead of new potable water supplies (CAPCOA 2010)
- Use graywater for non-potable uses instead of new potable water supplies (CAPCOA 2010)
- Use locally-sourced water supplies or water from less energy-intensive sources instead of imported water or other sources of water that have high energy intensities (CAPCOA 2010).
- Implement water pricing, such as metered rates, non-promotional rates, block rates, time-of-day pricing, water surcharges, and seasonal rates (USEPA 1998).
- Increase efficiency of existing hydropower facilities and operations (Merced ID 2008; TID and MID 2011).

Improving irrigation efficiency can be a mitigation measure because the surface water diversions primarily support agriculture in the plan area. Local water suppliers, regional groundwater management agencies, and irrigation districts could require modifications to existing agricultural practices to increase irrigation efficiency. To some extent, irrigation efficiencies have already resulted from the implementation of SBX7-7 requirements (see Section 11.3.1, *State [Regulatory Background]*) and as discussed by climate change mitigation strategies listed in Table 14-8 (e.g., California Water Plan 2009 and 2013 Updates [DWR 2010b]). Improving irrigation efficiency measures will reduce the overall amount of irrigation water needed because the water applied to the crops would have fewer losses to deep percolation and surface runoff. Furthermore, increasing irrigation efficiency may reduce the amount of supplemental groundwater pumping required to replace reduced surface water diversions. Increasing irrigation efficiency reduces the amount of water required for application without reducing the amount available for consumptive use. Increasing the irrigation efficiency could be done using the following methods.

- Increase the use of irrigation management services to better determine how much water is needed by crop and when to apply it.
- Convert current inefficient irrigation systems (e.g., surface irrigation) to more efficient ones (e.g., use of micro irrigation).
- Increase the capability of irrigation water suppliers to provide delivery flexibility, such as the use of irrigation district regulating reservoirs to allow flexible delivery durations, scheduling, and flow rates.

Any quantification of the effects of applying irrigation efficiency measures would be speculative; however, even with well-implemented irrigation efficiency measures, GHG emissions are not expected to be reduced to less-than-significant levels.

Many of the measures identified in the guidance documents are project-level measures appropriate for project-specific development. Individual projects will be subject to the appropriate level of environmental review at the time they are proposed, and mitigation would have to be identified to avoid or reduce significant effects, prior to any project-level action. Some potential actions, however, may not require discretionary approvals, and may not be subject to project-level CEQA review. For example, there is little to no project-level CEQA review of the potential increase in the use of percolating groundwater in areas that do not have a regulatory framework for groundwater management. Nevertheless, local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. It is infeasible for the State Water Board to impose mitigation measures at this time because it is undertaking a programmatic analysis of the potential GHG impacts and does not now have specific facts associated with an individual project to legally and technically apply the above mitigation measures in an adjudicative proceeding. The State Water Board will consider and impose these measures where legally supportable as part of individualized water right proceedings to implement the flow objectives.

In addition, while the State Water Board may impose water conservation or efficiency requirements through the adoption of regulations, the amount of time, high cost, and commitment of staff resources associated with such rule-making proceedings also renders adopting the mitigation measures now infeasible. Adopting regulations right now would require considerable staff time to research, formulate and develop, require extensive stakeholder outreach, and require numerous public meetings before the regulations would take effect. The State Water Board currently has limited resources to pursue adoption of such regulations as most of its budget for the water right program is supported by fees imposed on water right permit and license holders, and is used for program activities related to the diversion and use of water subject to the permit and license system. Only a small amount of funding is available for other regulatory activities and it is speculative to anticipate that additional funding will be made available. Therefore, at this time the imposition of the above mitigation measures is infeasible and impacts under LSJR Alternative 3 would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternative 2, adaptive implementation methods 2 and 4 are not expected to result in impacts on GHG emissions. Adaptive implementation method 3 would result in a shift in the volume of February–June water available to other parts of the year and is included in the modeling results presented above for LSJR Alternative 3. Because a change in the timing of the flow releases would not affect diversions or groundwater pumping, and on average it would have little effect on hydropower generation, method 3 would not substantially affect GHG emissions.

Adaptive implementation method 1 would allow an increase or decrease of up to 10 percent in the February–June, 40-percent unimpaired flow requirement (with a minimum of 30 percent and maximum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 40 percent to 30 percent or 40 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternatives 2 (less than significant) or 4 (significant and unavoidable), respectively. Because GHG emission impacts under LSJR Alternatives 3 and 4 are considered to be significant and adaptive implementation methods 1, 2, 3, and 4 would not alter this determination, LSJR Alternative 3 with adaptive implementation would cause significant GHG emissions.

The SED must identify feasible mitigation measures for each significant environmental impact identified in. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) As discussed above, guidance documents for possible GHG mitigation measures and possible methods to improve irrigation efficiency were reviewed and identified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. For the reasons stated above, at this time, it is infeasible for the State Water Board to impose the above mitigation measures. Therefore, impacts under LSJR Alternative 3 with adaptive implementation would remain significant and unavoidable.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As shown in Table 14-15, GHG emissions (62,984 MT CO_2e/year) would exceed the GHG threshold of 10,000 MT CO_2e/year and impacts would be significant. The increases associated with compensation for loss of hydropower and compensation for the predicted increased groundwater pumping are similar in magnitude (i.e., 31,285 and 31,698 MT CO_2e/year, respectively). As discussed in Section 14.4.2, *Methods and Approach*, the annual average of water exports is expected to increase approximately 4 percent under LSJR Alternative 4 relative to historic export levels. While it is anticipated that this slight increase in water exports would result in a slight increase in electricity consumption and associated GHG emissions, it is also expected that other water supply activities that may currently generate GHG emissions would be reduced as a result of the slight increase in exports as discussed under LSJR Alternative 3. Therefore, it is anticipated the modeled increase in exports would not contribute to a significant increase in GHG emissions.

The SED must identify feasible mitigation measures for each significant environmental impact identified in in. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(3).) As discussed above, guidance documents (under LSJR Alternative 3) for possible GHG mitigation measures and possible methods to result in better irrigation efficiency were reviewed and identified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. For the reasons stated above under LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose the above mitigation measures. Therefore, impacts under LSJR Alternative 4 would remain significant and unavoidable.

Adaptive Implementation

As discussed under LSJR Alternatives 2 and 3, adaptive implementation methods 2, 3, and 4 are not expected to result in changes to impacts on GHG emissions. Adaptive implementation method 1 would allow a decrease of up to 10 percent in the February–June, 60-percent unimpaired flow requirement (with a minimum of 50 percent) to optimize implementation measures to meet the narrative objective, while considering other beneficial uses, provided that these other considerations do not reduce intended benefits to fish and wildlife. Adaptive implementation must be approved using the process described in Appendix K. Accordingly, the frequency and duration of any use of this adaptive implementation method cannot be determined at this time. If the specified percent of unimpaired flow were changed from 60 percent to 50 percent on a long-term basis, the conditions and impacts could become more similar to LSJR Alternative 3 (i.e., less severe for GHG emissions, but still significant). Similar to the impact determination of LSJR Alternative 3 and 4, impacts would be significant. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified above. For the reasons stated above in LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose the above mitigation measures. Therefore, impacts under LSJR Alternative 4 with adaptive implementation would remain significant and unavoidable.

Impact EG-4: Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

Clean Air Act (CAA) requirements for GHGs are the GHG emissions standards for vehicles and do not apply to projects that do not generate GHG emissions from vehicles. GHG emissions from the largest stationary sources (such as electricity utilities, refineries, etc.) are typically covered by CAA Prevention of Significant Deterioration (PSD) and Title V Operating Permit Programs. This requires permitting for facilities in excess of 100,000 MT CO_2e/year. The electric utilities that could be affected by the LSJR alternatives as a result of reduced hydropower or increased groundwater pumping would be subject to these permitting requirements regardless of LSJR alternatives, and the LSJR alternatives would not alter or modify these permit requirements. Therefore, the LSJR alternatives would not conflict with the requirements or CAA.

A GHG threshold of 10,000 MT CO_2e per year has been adopted by SCAQMD and BAAQMD and was used for this analysis. In using this threshold for the analysis, the following considerations were made: consistency with a GHG reduction plan,[9] the predicted emissions reductions from statewide regulatory measures and resulting emissions inventories, and the efficacies of GHG mitigation measures. It addresses a broad range of combustion sources and thus provides for a greater amount of GHG reductions to be analyzed and mitigated through the CEQA process. (BAAQMD 2010) Therefore, the LSJR alternatives would conflict with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions if the GHG emissions generated by the alternatives are greater than the GHG threshold of 10,000 MT CO_2e per year.

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[9] There is no acceptable GHG reduction plan from which to evaluate project significance consistent with State CEQA Guidelines Sections 15183.5 and 16064.4(b)(3).

LSJR Alternative 2 (Less than significant/Less than significant with adaptive implementation)

As discussed for Impact EG-3, LSJR Alternative 2 is expected to reduce GHG emissions. Therefore, the alternative is not expected to conflict or be inconsistent with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions. This impact would be less than significant.

Adaptive Implementation

As discussed for Impact EG-3, incorporation of adaptive implementation could potentially increase GHG emissions, but emissions would still be well below 10,000 MT of CO_2e per year. Therefore, impacts would be less than significant.

LSJR Alternative 3 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As discussed for Impact EG-3, LSJR Alternative 3 would generate GHG emissions in excess of 10,000 MT of CO_2e per year, which is considered to be inconsistent with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions. This impact would be significant. Implementation of the measures discussed in Impact EG-3 would reduce GHG emissions, but cannot be quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated in Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

Adaptive Implementation

As discussed for Impact EG-3, incorporation of adaptive implementation could increase GHG emissions if adaptive implementation method 1 results in a long-term increase in the unimpaired flow requirement. Therefore, impacts would be significant. Similar to LSJR Alternative 3, implementation of the measures discussed in Impact EG-3 would reduce GHG emissions but cannot be quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated above in Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

LSJR Alternative 4 (Significant and unavoidable/Significant and unavoidable with adaptive implementation)

As discussed for Impact EG-3, LSJR Alternative 4 would generate GHG emissions in excess of 10,000 MT of CO_2e per year, which is considered to be inconsistent with the state goals listed in AB 32 or in any preceding state policies and plans adopted to reduce GHG emissions. This impact would be significant. Implementation of the measures discussed for Impact EG-3 would reduce GHG emissions, but cannot be fully quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

Adaptive Implementation

As discussed for Impact EG-3, incorporation of adaptive implementation could increase GHG emissions if adaptive implementation method 1 results in a long-term increase in the unimpaired flow requirement. Therefore, impacts would also be significant. Similar to LSJR Alternative 4, implementation of the measures discussed in Impact EG-3 would reduce GHG emissions but cannot be quantified. Local water districts and suppliers, regional groundwater agencies, irrigation districts, and local agencies and governments can and should, either voluntarily or as required by CEQA when approving discretionary projects that are undertaken in response to the LSJR alternatives, adopt the relevant mitigation measures identified in Impact EG-3 for LSJR Alternative 3. For the reasons stated Impact EG-3 for LSJR Alternative 3, at this time, it is infeasible for the State Water Board to impose those mitigation measures. Consequently, this impact would remain significant and unavoidable.

Impact EG-5: Effect of climate change on the LSJR and SDWQ alternatives

No Project Alternative (LSJR/SDWQ Alternative 1)

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative impact discussion and Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1),* for the No Project Alternative technical analysis.

LSJR Alternatives

As discussed in Section 14.2.3, *Climate Change*, and Section 14.3, *Regulatory Background,* scientific studies and sources agree that the San Joaquin Valley and the Delta will experience changes to the historical hydrology as a result of climate change. It is expected that climate change will result in higher temperatures, increased heat waves, changes in rainfall patterns, and sea level rise (DWR 2010a, 2010b; USBR 2014, 2016). In addition, reduced snow pack and stream flow in the Sierra Nevada is expected to lead to changes in water supply into the Delta region (DWR 2010a, 2010b; USBR 2014, 2016). Depending on the climate change scenarios evaluated in the scientific studies, it has been predicted that climate change will affect snow pack, runoff, water supply reliability, water quality and quantity, aquatic ecosystems, evapotranspiration, and hydropower. Specifically, from scenarios compiled for the IPCC's Fourth Assessment Report, four climate change scenarios were selected for DWR's climate change studies. The four climate change scenarios consist of two GHG emissions scenarios, A2 and B1, each represented by two different global climate models, the Geophysical Fluid Dynamic Lab (GFDL) model and the Parallel Climate Model (PCM) model, respectively. The A2 emissions scenario assumes high population growth, regional based economic growth, and slow technological changes that results in significantly higher GHG emissions. The B1 scenario represents low population growth, global based economic growth, and sustainable development that results in the lowest increase of GHG emission of the IPCC scenarios. Both models project future warming; however, the GFDL model indicates a greater warming trend than the PCM model.

Hydrology impacts associated with the different climate change scenarios are summarized below. These summaries are based on of the CWP 2013 Update, Chapter 3: *California Water Today, Regional Reports for San Joaquin River Hydrologic Region and Sacramento-San Joaquin Delta*, and Chapter 22: *Ecosystem Restoration* (The California Natural Resources Agency and DWR 2013). The summaries are also consistent with information contained in the *Sacramento and San Joaquin Basins Climate Impact Assessment* (USBR 2014, 2016).

- **Reduced water supply and reliability.** Climate change is anticipated to bring heavier and warmer storms in the winter that result in less snowfall at lower elevations, reduce the total snowpack, and shift the timing of associated runoff, which in turn affects water storage capability in reservoirs and reduces water supply availability and reliability to water users. Much of the state's water infrastructure was designed to capture the slow spring snowmelt and deliver it during the drier summer and fall months. However, as average temperatures continue to increase, the snowpack will melt earlier, resulting in increased winter runoff and reduced spring snowmelt. Intense rainfall events and rapid snowmelt will make water more difficult to capture in reservoirs or retain for groundwater recharge and, therefore, reduce the region's water supply.
- **Increased water demand.** Climate change is expected to increase the water demand for both agricultural and urban use as a result of rising temperatures, increased evapotranspiration, reduced chill-hours in winter, and increased frequency and intensity of droughts. Higher temperatures are likely to extend growing seasons and also increase evapotranspiration, thereby increasing the amount of water that is needed for the irrigation of certain crops, urban landscaping, and environmental needs.
- **Degraded water quality.** Climate change is expected to degrade water quality as a result of rising temperatures and changed precipitation patterns. Higher water temperatures result in reduced dissolved oxygen levels in the water, which can have an adverse effect on water quality. Where river and lake levels fall due to increased evapotranspiration and changed precipitation and runoff patterns, pollutant concentrations in water will increase. Increased frequency and intensity of rainfall result in more direct runoff and flooding, which will produce more pollution and sedimentation in river and lakes. Sea level rise increases sea water intrusion into the Delta, which will further increase salinity in Delta and degrade drinking and agricultural water quality and alter ecosystem conditions in the region.
- **Altered aquatic ecosystems.** Climate change is anticipated to affect aquatic life due to rising temperatures, changes in river flow, and the continued rise in sea level. Higher water temperatures result in reduced dissolved oxygen levels, which can have an adverse effect on aquatic life. In many low- and middle-elevation streams in the region today, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate this problem. Increases in water temperature and reductions in cold water in upstream reservoirs to be released in in spring and summer will also exacerbate this problem and hurt spawning and recruitment success of native fishes. For example, summer water temperatures in the major SJR tributaries upstream from the major reservoirs currently cause stress for coldwater species, such as steelhead/rainbow trout, and also for hardhead and Kern brook lamprey. By 2030, average summer air temperatures are expected to rise as much as 8°F, and water temperatures in the major SJR tributaries and their

reservoirs are expected to measurably increase. Significant increases in water temperatures could significantly impact rainbow trout and land-locked Kokanee that reside in and above the reservoirs. Surface water temperatures are also expected to rise in the reservoirs, but most of the species in the reservoirs are warmwater species that would not be affected by the expected water temperature increases or potential associated decreases in DO concentrations. Juveniles and smolts may become exposed to further reductions in the availability of coldwater habitat below dams and increasing abundance of nonnative warmwater species that prey on salmonids (Katz et al. 2013)

Inflow from the major SJR tributaries is expected to increase during winter months and decrease during spring and early summer months because of reduced snowpack associated with climate change. The changes in seasonal inflows are likely to affect Central Valley fall-run Chinook salmon, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley steelhead, green sturgeon, Sacramento splittail, longfin smelt, and delta smelt. Spawning migrations and other lifecycle processes of these species are adapted to high spring flows in the major SJR tributaries and into the Delta, and reductions in these flows would have significant impacts on several life stages.

Continued rise in sea level and upstream encroachment of salt water will affect aquatic habitat. Average sea levels are expected to rise about 1 foot by 2030, which would cause increased salinities in the Delta. Delta smelt and longfin smelt spawn in the fresher water portions of the Delta, and delta smelt remain in areas with low salinities throughout their lifecycle. Increased salinity would be stressful to delta smelt and longfin smelt, particularly during their egg and larval stages. The brackish and fresh aquatic habitats of the Sacramento–San Joaquin Estuary, which are critical to many at-risk species, will be forced to shift upstream and inland.

- **Declined hydropower generation.** The energy sector is also vulnerable to potential impacts of climate change. This vulnerability has been evaluated by a modeling study simulating hydropower generation under regional climate warming in the Sierra Nevada. This study indicates the most substantial decrease of the mean annual hydropower generation will be in the northern Sierra Nevada watersheds as a result of declining runoff. The study also projects that with rising temperatures there will be steady declines in hydropower generation in the southern watersheds.

As discussed in Section 14.3.2, *State [Regulatory Background]*, CWP is the long-term strategic plan for guiding the management and development of water resources in the state. The CWP Update 2009 incorporated climate change in water plan scenarios to evaluate impacts on California's water resources and to identify and recommend statewide and regional adaptation strategies. The current Update 2013 builds on the contents of the Update 2009 and includes regionally appropriate and statewide water management and planning adaptation and mitigation strategies, resource management strategies, and decision support for climate change scenarios. Many of the resource management strategies provide benefits for adapting to climate change in addition to meeting water management objectives. As discussed in Section 14.3.3, *Regional or Local [Regulatory Background]*, the AWMPs prepared by irrigation districts, summarized in Table 14-8, have sections that discuss the expected effects of climate change on water supply, demand, and quality within their irrigation districts and recommend implementation of climate change mitigation strategies identified in the CWP 2009 and 2013 Updates. The UWMPs, summarized in Table 14-9, have sections that discuss the expected effects of climate change on water supply and demand within their service areas and identify planning recommendation or actions to mitigate the effects of climate change. The various strategies aim to reduce water demand include the following.

- **Reduce water demand**: agricultural/urban water use efficiency.
- **Improve operational efficiency**: regional/local conveyance; system reoperation.
- **Increase water supply**: conjunctive management and groundwater; precipitation enhancement; regional/local surface storage.
- **Improve water quality**: pollution prevention; salt and salinity management.
- **Practice resource stewardship**: ecosystem restoration; land use planning and management; recharge area protection; watershed management.

LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3 (Less than significant)

The LSJR alternatives, with or without adaptive implementation, would be subject to climate change impacts discussed above resulting from past, present, and future GHG emissions regardless of the success of local, state, national, or international efforts in reducing future GHG emissions due to the existing concentrations of GHG emissions in the atmosphere and the inevitable additional emissions before GHG reductions plans provide reductions. As mentioned earlier, potential climate change impacts in California and the San Joaquin Valley might include sea level rise, saltwater intrusion, reduced snowpack and water supplies, and increased water demand.

Less snowpack and earlier runoff potentially means that there will be a reduced water supply later in the year because reservoir capacity is limited and water may be released earlier than usual. The problem of low water supply would likely be compounded by higher air temperatures, which would likely result in an increase in the amount of water needed to grow crops. The LSJR alternatives have the potential to exacerbate the water supply condition under climate change because they generally would reduce water supplies (particularly LSJR Alternatives 3 and 4).

Less snowpack and earlier runoff means that runoff from December–March may increase, whereas runoff from April–July may decrease (California Natural Resources Agency and DWR 2013; USBR 2014, 2016) relative to baseline conditions. In general, the earlier runoff would likely result in greater flood control releases from December–March. The increase in February–March flood control releases that may be expected with climate change may be reduced by implementation of the LSJR alternatives. This is because the LSJR alternatives would require increased reservoir releases, which would thereby increase the available storage space in reservoirs.

In the absence of the LSJR alternatives, increased flood control releases would make the flow downstream of the reservoirs closer to the magnitude of the unimpaired flow under climate change. During a large runoff event, flood control releases in the absence of the LSJR alternatives might equal or exceed what would be required by one of the LSJR alternatives. As a result, climate change may help attain February–March flows required by the LSJR alternatives.

The SDWQ alternatives and the program of implementation would maintain the existing Vernalis EC. As such, water would continue to be required to be released from New Melones Reservoir. Similar to the conditions described above with the LSJR alternatives, less snow pack and earlier runoff means that there may be less water later in the season, and it may be more difficult to release water from New Melones Reservoir under climate change conditions.

The LSJR alternatives are based on a percent of unimpaired flow. If the unimpaired flow is less under climate change conditions, then the amount of water required by the LSJR alternatives would also be less. In addition, the adaptive implementation methods of the LSJR alternatives would provide the State Water Board and the Stanislaus, Tuolumne, and Merced Working Group the ability to respond to changing circumstances with respect to flow and water quality that may arise due to climate change (e.g., more rain and less snow pack) as it relates to protecting beneficial uses such as fish and wildlife on the three eastside tributaries and agricultural uses in the southern Delta. Finally, the State Water Board is required to prepare WQCPs and regularly review the plans to update water quality standards, as they are currently doing evaluating the LSJR and SDWQ alternatives. Consistent with this requirement, the program of implementation for the LSJR and SDWQ alternatives includes updates to the 2006 Bay-Delta Plan as information becomes available upon implementation of the objectives, including through monitoring and special studies. As a result, the planning process continually accounts for changing conditions related to water quality and water planning, such as climate change. Because the State Water Board is preparing for the effects of climate change on its programs and adaptive implementation would account for circumstances that arise from climate change, this impact would be less than significant.

14.4.4 Impacts and Mitigation Measures: Extended Plan Area

Bypassing flows, as described in as described in Chapter 5, *Surface Hydrology and Water Quality* could potentially impact energy (hydropower electrical production) resources in upstream reservoirs in the extended plan area on the Stanislaus and Tuolumne Rivers because these two rivers have major reservoirs that are used to produce hydropower. These potential impacts could occur if reservoirs experienced substantial reductions in reservoir volume, especially during drought conditions under LSJR Alternative 3 and LSJR Alternative 4 with or without adaptive implementation. Hydropower production is related to both water discharge volume and reservoir head (elevation difference between the reservoir surface and the hydropower outlet). Lower reservoir volumes would reduce head and could reduce discharge to some extent. However, under baseline conditions these reservoirs undergo substantial annual elevation and volume reduction as hydropower is produced and water is released for instream flow requirements (USGS Reservoir Gage Data). Consequently the hydropower production effects associated with the reservoir volume reduction under LSJR Alternatives 2 and 3 (in most years) would be similar to baseline conditions, even with adaptive implementation. These volume reductions, however, would occur more frequently and be more severe during drought conditions, particularly under LSJR Alternatives 3 and LSJR Alternative 4 with or without adaptive implementation and, to a lesser extent, LSJR Alternative 2 with adaptive implementation. Consequently there could be significant hydropower production reductions at reservoirs under these LSJR alternatives in the extended plan area.

Additional GHG production would occur in the extended plan area if service providers and individuals had to increase groundwater pumping to replace junior water bypassed to achieve the required flows in the Stanislaus, Tuolumne, and Merced Rivers, and the LSJR. However, in these circumstances the volume of bypassed junior water would reduce the amount that downstream users would need to pump from groundwater. Therefore, the amount of additional GHG production related to upstream groundwater pumping impacts in the extended plan area would be offset by equivalent reductions in the downstream plan area. GHG production could also be affected by potentially reducing hydropower production at reservoirs in the extended plan area if hydropower is replaced by non-renewable energy sources, which produce greater amounts of GHGs. As noted above, there is the potential there could be adverse hydropower production impacts at reservoirs under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation in the extended plan area. Consequently, there could be related adverse GHG production impacts in the extended plan area.

The increased frequency of lower reservoir levels resulting from the LSJR alternatives and the associated physical changes in hydropower and GHGs, however, would be limited by the program of implementation under each of the LSJR alternatives. The program of implementation requires minimum reservoir carryover storage targets or other requirements to help ensure that providing flows to meet the flow objectives will not have adverse temperature or other impacts on fish and wildlife or, if feasible, on other beneficial uses (e.g., hydropower). Other requirements, for example, include, but are not limited to, limits on required bypass flows for reservoirs that store water only for non-consumptive use so that some water can be temporarily stored upstream. The program of implementation also states that the State Water Board will take actions as necessary to ensure that implementation of the flow objectives does not impact supplies of water for minimum health and safety needs, particularly during drought periods. Accordingly, when the State Water Board implements the flow objectives in a water right proceeding, it will consider impacts on fish, wildlife, and other beneficial uses, such as hydropower, and health and safety needs, along with water right priority. Until the State Water Board assigns responsibility to meet the flow objectives in the Bay-Delta Plan, it is speculative to identify the exact extent, scope and frequency of reduced diversions, reduced reservoir levels and their effects on hydropower and GHG emissions, in the extended plan area. When implementing the flow objectives, the State Water Board would identify project-specific impacts and avoid or mitigate significant impacts of lower reservoir levels on hydropower and GHGs in accordance with CEQA.

At the time of preparation of this programmatic analysis, it is unclear to what extent any significant impacts could be fully mitigated to hydropower and GHG. Thus, the potential exists for significant impacts. Therefore, this analysis conservatively concludes that impacts associated with lower reservoir levels under LSJR Alternatives 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation are significant. The following mitigation measure is proposed: When considering carryover storage and other requirements to implement the flow water quality objectives in a water right proceeding, the State Water Board shall ensure that reservoir levels upstream of the rim dams do not cause significant hydropower and GHG impacts, unless doing so would be inconsistent with applicable laws. The impact is considered significant even with mitigation, because the mitigation may not fully mitigate the impact in all situations.

14.5 Cumulative Impacts

For the cumulative impact analysis, refer to Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources.*

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Chapter 15
No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)

15.1 Introduction

The California Environmental Quality Act (CEQA) Guidelines require that the potential impacts of not approving a proposed project be evaluated under a No Project Alternative. "The purpose of describing and analyzing a no project alternative is to allow decision makers to compare the impacts of approving the proposed project with the impacts of not approving the proposed project." (Cal. Code Regs., tit. 14, § 15126.6(e)(1).) When the project is the revision of an existing regulatory plan, such as the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan), the No Project Alternative will be the continuation of the existing plan as currently implemented into the future. (Cal. Code Regs., tit. 14, § 15126.6(e)(3)(A).) In general, the existing plan and the projects initiated under the existing plan would continue until the new plan amendments[1] are approved. The No Project Alternative analysis must discuss the existing conditions "as well as what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services." (Cal. Code Regs., tit. 14, § 15126.6(e)(2).)

For the purposes of this analysis, the No Project Alternative is the continuation of the State Water Resources Control Board's (State Water Board) 2006 Bay-Delta Plan, as implemented through the State Water Board's Water Right Decision 1641 (D-1641), including implementation of the San Joaquin River (SJR) at Vernalis flow objectives (also referred to as the SJR flow objectives) and the southern Delta salinity (EC[2]) objectives (including the salinity objective on the SJR at Vernalis). Lower San Joaquin River (LSJR) Alternative 1 and Southern Delta Water Quality (SDWQ) Alternative 1 are referred to as the No Project Alternative in this recirculated substitute environmental document (SED).

This chapter describes the No Project Alternative and the environmental impacts of the alternative compared to impacts under the proposed plan amendments. The No Project Alternative is not baseline for determining whether the impacts of the proposed plan amendments are significant. Baseline is described in Chapter 4, *Introduction to Analysis*, and in the environmental setting section of each resource chapter. The environmental impacts of the other alternatives are described in Chapters 5–14. The cumulative impacts of the No Project Alternative are described in this chapter and the cumulative impacts of the other project alternatives are analyzed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*. The impacts for all project alternatives, including the No Project Alternative, are summarized in Chapter 18, *Summary*

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[1] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

[2] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

of Impacts and Comparison of Alternatives. The No Project Alternative focuses on effects related to implementation of Vernalis flow and southern Delta salinity objectives because these objectives are the ones proposed to be amended. The environmental impacts of the No Project Alternative were evaluated by comparing the State Water Board's Water Supply Effects (WSE) modeling results for the No Project Alternative to baseline and the other alternatives (summarized in Table 15-1).

Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, describes the assumptions used in the WSE modeling of the baseline and No Project Alternative and modeling results. This chapter uses the data and results presented in Appendix D to analyze and summarize the expected impacts associated with the No Project Alternative. Select Appendix D figures and tables are duplicated in this chapter.

The WSE model is discussed in further detail in Appendix F.1, *Hydrologic and Water Quality Modeling*.

15.2 Description of the No Project Alternative

The No Project Alternative assumes continued implementation of, and full compliance with, the 2006 Bay-Delta Plan, as implemented through D-1641. The No Project Alternative focuses on efforts related to the implementation of Vernalis flow and southern Delta salinity objectives because these objectives are the ones proposed to be amended. The Vernalis flow objectives were first established in the 1995 Bay-Delta Plan to protect fish and wildlife beneficial uses. These objectives include the minimum monthly flow rates for fish and wildlife beneficial uses during specific times of the year, as presented in Table 3 of the 2006 Bay-Delta Plan and implemented through D-1641. In D-1641, the State Water Board assigned compliance with these minimum flows on the SJR at Vernalis to the U.S. Bureau of Reclamation (USBR). When the State Water Board subsequently amended the Bay-Delta Plan in 2006, it approved an interim flow regime through the Vernalis Adaptive Management Program (VAMP) experiment, as proposed in the San Joaquin River Agreement (SJRA), in lieu of meeting the April–May pulse flow objective (as presented in Table 3 of the 2006 Bay-Delta Plan).

No Project Alternative conditions differ from the baseline because the Vernalis flow objectives in Table 3 of the 2006 Bay-Delta Plan have not been fully implemented and are not part of the baseline because of implementation of the SJRA and VAMP. The VAMP flows, which are generally lower than the Table 3 flows in the 2006 Bay-Delta Plan, are thus included in the baseline. During VAMP, a portion of the flows needed to comply with VAMP came from the three eastside tributaries[3]even though the 2006 Bay-Delta Plan and D-1641 do not contain numeric or narrative flow requirements specific to these rivers. However, the No Project Alternative does not include VAMP flows because that experimental flow regime concluded in 2011. The No Project Alternative and the baseline both include the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BO) flow requirements on the Stanislaus River, Federal Energy Regulatory Commission (FERC) requirements on the Tuolumne and Merced Rivers, and the Davis-Grunsky requirements on the Merced River.

The No Project Alternative assumes that the flows would continue to be the responsibility of USBR and that the objectives would be met with additional releases from New Melones Reservoir on the Stanislaus River. There are other possible ways that compliance with the objectives could be achieved, but it is speculative to identify which other measures, or combination of measures, would be used. For example, the flow objective could be achieved by a combination of releases from New

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[3] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

Melones Reservoir and other actions (e.g., water purchases and transfers among different water users and other upstream SJR actions [such as SJR Restoration Program[4] flows]). However, these other actions are difficult to predict or quantify. The analytical approach used here evaluates increased releases from New Melones Reservoir to meet the objectives, because such releases could be the primary method by which the Vernalis flow objectives and southern Delta salinity objectives would be achieved. Focusing the evaluation on New Melones Reservoir releases affords an evaluation of maximum potential water supply impacts compared to assuming that increases in Vernalis flow would be distributed among the tributaries.

The No Project Alternative also assumes the continuation of the southern Delta salinity objectives for agricultural beneficial uses, as identified in Table 2 of the 2006 Bay-Delta Plan, and full compliance with these objectives as implemented through D-1641. Under D-1641, compliance with the numeric salinity objectives on the SJR at Vernalis (station C-10) is the obligation of USBR. Compliance with the numeric salinity objectives at the three interior southern Delta compliance stations—SJR at Brandt Bridge (station C-6), Old River near Middle River (station C-8), and Old River at Tracy Road Bridge (station P-12)—are the combined obligation of USBR and the California Department of Water Resources (DWR).

15.3 Model Results

WSE model results for the No Project Alternative are compared to the baseline for the three eastside tributaries in Appendix D *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1).* This chapter summarizes model results focused on flow, as presented in Appendix D. Figures 15-1a through 15-1c compare the annual baseline flows to the annual No Project Alternative flows for the Stanislaus, Tuolumne, and Merced Rivers, respectively. Table 15-1 compares the monthly cumulative distributions of baseline flow and differences from baseline for the No Project Alternative for the three eastside tributaries and the SJR. Figures 15-2 through 15-5 are exceedance plots for the three eastside tributaries and the SJR, which present the No Project Alternative, the baseline, and the LSJR alternative WSE model results for (a) February–June flow volumes, (b) end-of-September storage (i.e., carryover), (c) diversions, and (d) February–June flow as a percentage of the unimpaired flow[5]. The exceedance plots present the results for the LSJR alternatives to evaluate No Project Alternative impacts if the hydrologic effects of the No Project Alternative are within the range of hydrologic effects evaluated for the LSJR alternatives in Chapters 5–14.

15.3.1 Stanislaus River

The No Project Alternative would greatly affect flow, storage, and water supply diversions on the Stanislaus River. WSE model simulations for all LSJR alternatives and baseline assume Vernalis salinity objectives are met by increased New Melones Reservoir releases if necessary. As described in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, the No Project Alternative would result in additional New Melones Reservoir releases to meet

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[4] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future.

[5] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

D-1641 Vernalis flow objectives and D-1641 salinity objectives for south Delta compliance locations downstream of Vernalis. As such, under the No Project Alternative, Stanislaus River February–June flow volumes are generally higher than they were under baseline (Table 15-1, Figure 15-1, and Figure 15-2a). The additional releases required under the No Project Alternative would reduce end-of-September storage (i.e., carryover) in New Melones Reservoir and the volume of water available for diversions along the Stanislaus River. The WSE model results show that New Melones Reservoir carryover storage under the No Project Alternative is lower than it is under baseline in almost all years (1922–2003) (Figure 15-2b). Additionally, the model shows that No Project Alternative diversions from the Stanislaus River are less than baseline diversions in approximately 50 percent of the years; No Project Alternative diversions are substantially reduced during approximately 15 percent of the years (Figure 15-2c).

No Project Alternative flow and storage volumes were also compared to the LSJR alternatives on the Stanislaus River (Figures 15-2a through 15-2d). Under the No Project Alternative, Stanislaus River February–June flow volumes are generally greater than LSJR Alternative 2 flow volumes, except in approximately 35 percent of the wetter years. No Project Alternative flow volumes are less than the LSJR Alternative 3 flow volumes in approximately 65 percent of years, and except under very dry conditions, the No Project Alternative flow volumes are generally much less than the LSJR Alternative 4 flow volumes (Figure 15-2a). New Melones Reservoir carryover storage is similar to or less than storage under LSJR Alternatives 2 and 3 in all years; storage is less than LSJR Alternative 4 storage in approximately half of the years (Figure 15-2b). Lastly, diversions are generally similar to or less than they are under LSJR Alternative 2, especially during drought years; however, the diversions under the No Project Alternative are usually much greater compared to LSJR Alternatives 3 and 4, except again in the driest years when diversions are close to zero (Figure 15-2c).

15.3.2 Tuolumne, Merced, and Lower San Joaquin Rivers

The No Project Alternative would affect the Tuolumne and Merced Rivers differently than it would affect the Stanislaus River. Under baseline, some of the Vernalis flow requirements would come from the Tuolumne and Merced Rivers as part of VAMP (Table D-3). Under the No Project Alternative, the VAMP flows would no longer be in effect; releases to satisfy Vernalis flow requirements would come entirely from the USBR through releases at New Melones Reservoir on the Stanislaus River (Table D-3).

As discussed in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, Tuolumne River February–June flows (Figures 15-3a and 15-3d), reservoir storage (Figure 15-3b), and diversions (Figure 15-3c) are similar under baseline and the No Project Alternative. The VAMP flows, which are included in the baseline, come primarily from the Stanislaus and Merced Rivers; therefore, replacing VAMP with the full implementation of D-1641, as called for under the No Project Alternative, has minimal effect on the Tuolumne River.

Under the No Project Alternative, February–June flows on the Merced River are lower than they are under baseline in more than 50 percent of years (Figure 15-4a); reduced flows occur during the VAMP months of April and May (Table 15-1). The lower flows under the No Project Alternative would increase the carryover storage in Lake McClure (Figure 15-4b), which is located on the Merced River..

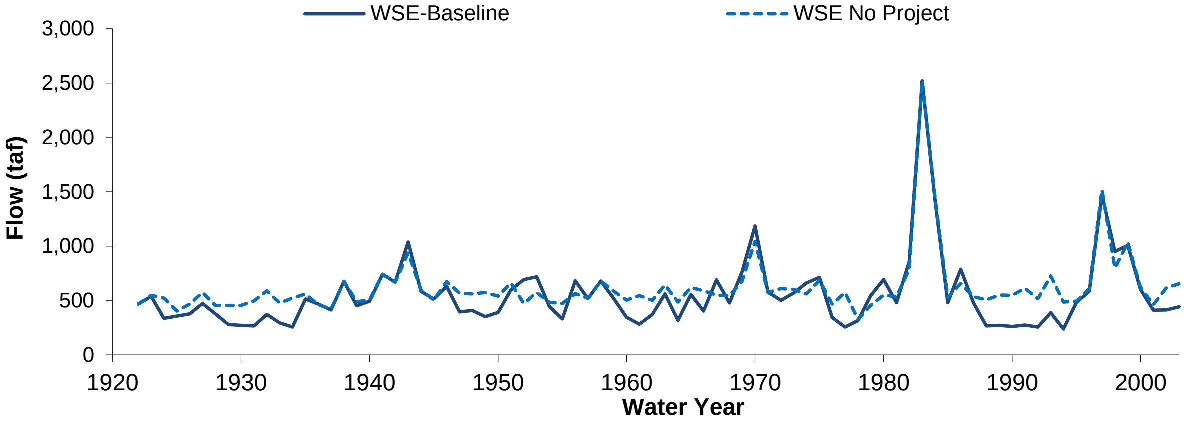
Lastly, driven by the increases in flow on the Stanislaus River, total SJR February–June flows at Vernalis are slightly higher under the No Project Alternative than they are under baseline

(Table 15-1 and Figure 15-5a). In most years, total February–June flows experienced similar increases under LSJR Alternative 2 and the No Project Alternative. However, during the driest years, total February–June flows are slightly lower under LSJR Alterative 2 than they are under the No Project Alternative (Figure 15-5a). In addition, during July and August flows sometimes increase slightly under the No Project Alternative relative to baseline (Table 15-1).

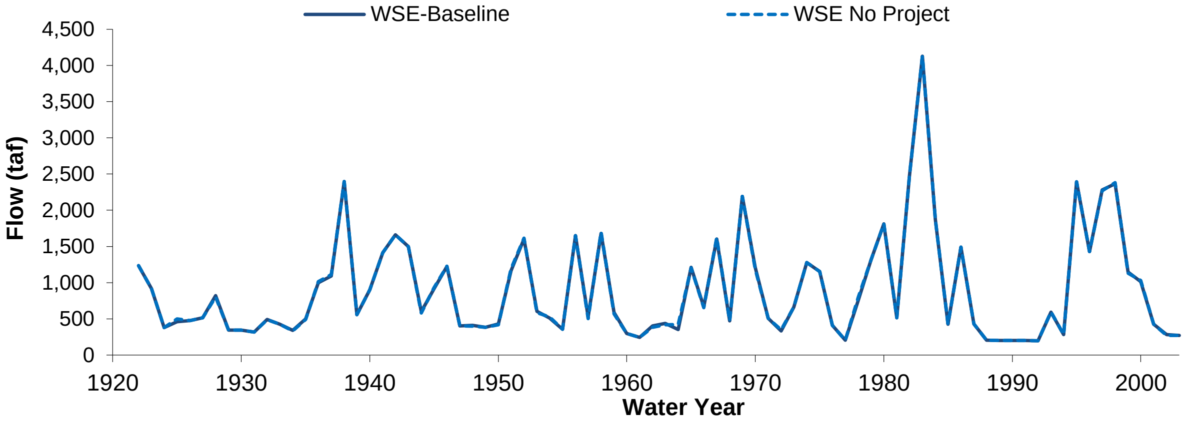
Table 15-1. Monthly Cumulative Distributions of Baseline Flow and Differences from Baseline for the No Project Alternative for the 82-Year WSE Modeling Period

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Stanislaus Flow at Ripon – Baseline												
10	729	248	224	270	230	308	573	525	292	293	302	311
50	889	319	288	337	385	486	1,556	1,422	629	437	416	419
90	1,116	454	421	576	1,285	1,911	1,997	2,107	1,655	705	632	667
No Project – Percent Difference from Baseline												
10	-3	0	1	9	5	1	82	66	121	98	47	-8
50	-4	0	7	3	32	31	10	12	49	73	47	0
90	-1	-1	-3	-1	0	0	14	11	-8	44	43	-6
Tuolumne Flow at Modesto (cfs) – Baseline												
10	290	246	257	316	312	349	546	546	270	262	277	256
50	550	464	470	570	647	1,568	1,414	1,238	499	448	426	422
90	813	756	1,152	3,424	5,084	5,097	4,591	4,810	4,387	3,331	652	691
No Project – Percent Difference from Baseline												
10	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	1	2	11	0	-6	-12	0	0	0	0
90	0		0	0	0	0	0	0	0	0	0	0
Merced Flow at Stevinson (cfs) – Baseline												
10	325	266	277	280	312	283	150	117	88	55	32	55
50	423	338	348	385	450	384	508	473	225	155	163	170
90	548	419	991	1,621	2,556	1,728	973	2,478	2,981	2,113	1,150	544
No Project – Percent Difference from Baseline												
10	0	2	0	0	0	0	-29	-76	0	0	0	0
50	0	1	0	0	0	0	-54	-52	4	0	6	2
90	3	6	2	0	14	0	-5	0	0	0	0	0
San Joaquin River Flow at Vernalis (cfs) – Baseline												
10	2,000	1,566	1,513	1,481	1,856	1,614	1,616	1,543	1,009	959	1,055	1,488
50	2,598	1,981	1,941	2,200	3,489	3,502	4,640	4,600	2,280	1,620	1,544	2,024
90	3,331	2,724	4,264	10,926	15,228	13,821	12,538	13,327	11,586	6,902	2,983	2,940
No Project – Percent Difference from Baseline												
10	0	0	8	5	17	21	42	22	64	71	50	0
50	-1	0	1	1	1	1	0	-3	0	18	10	-1
90	-1	2	0	0	1	0	0	1	-1	-1	-2	-2

a) Annual Flow in the Stanislaus River near Ripon



b) Annual Flow in the Tuolumne River near Modesto



c) Annual Flow in the Merced River near Stevinson

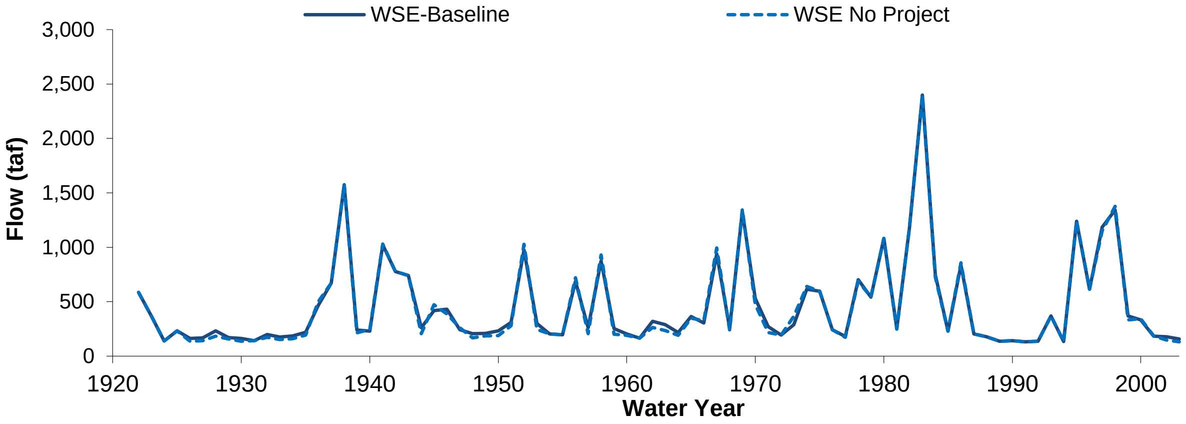


Figure 15-1. Comparison of Baseline and No Project Alternative Annual Flow Volume (TAF = thousand acre-feet) for the (a) Stanislaus, (b) Tuolumne, and (c) Merced Rivers near Their Confluences with the San Joaquin River from 1922–2003

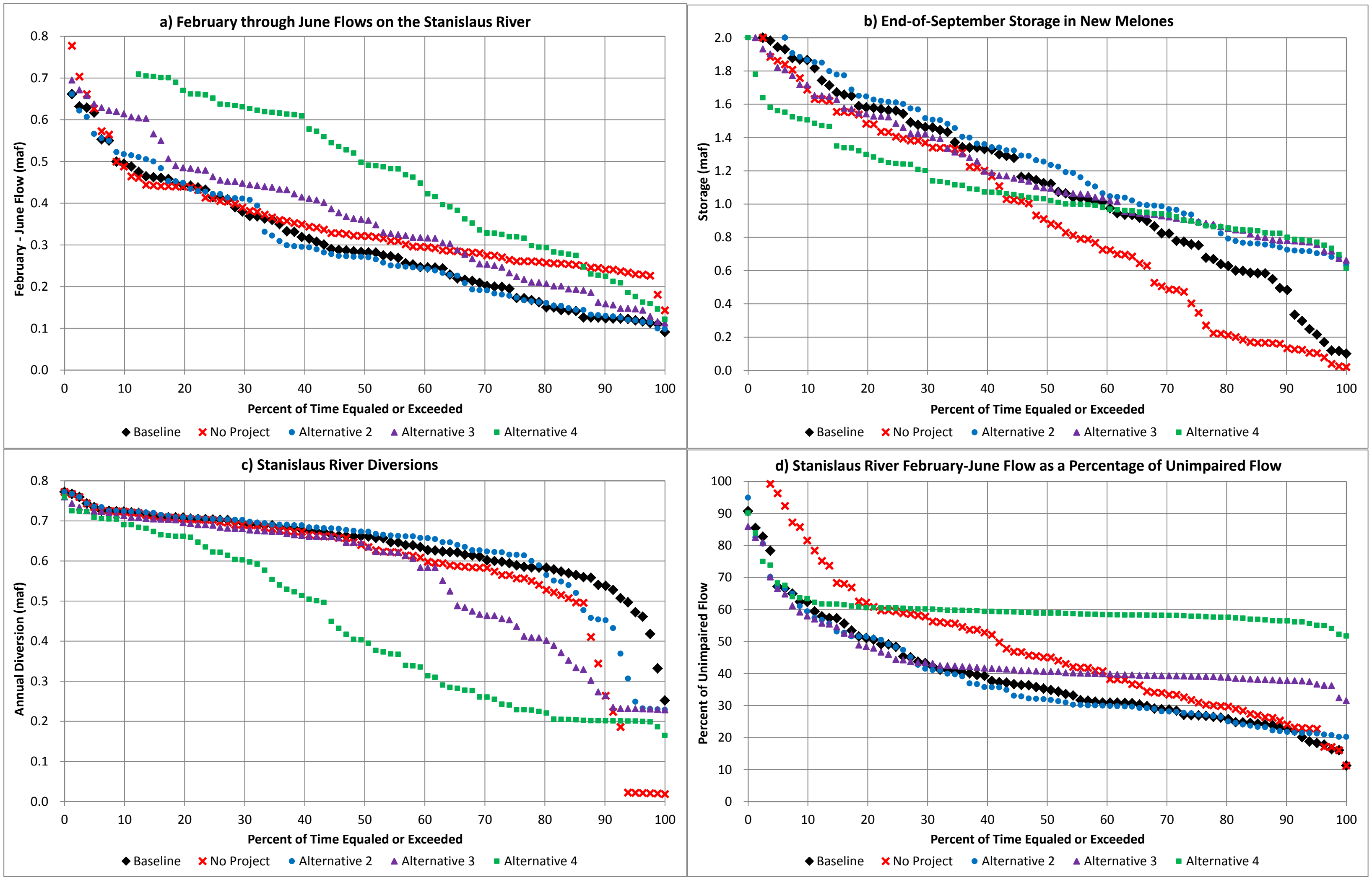
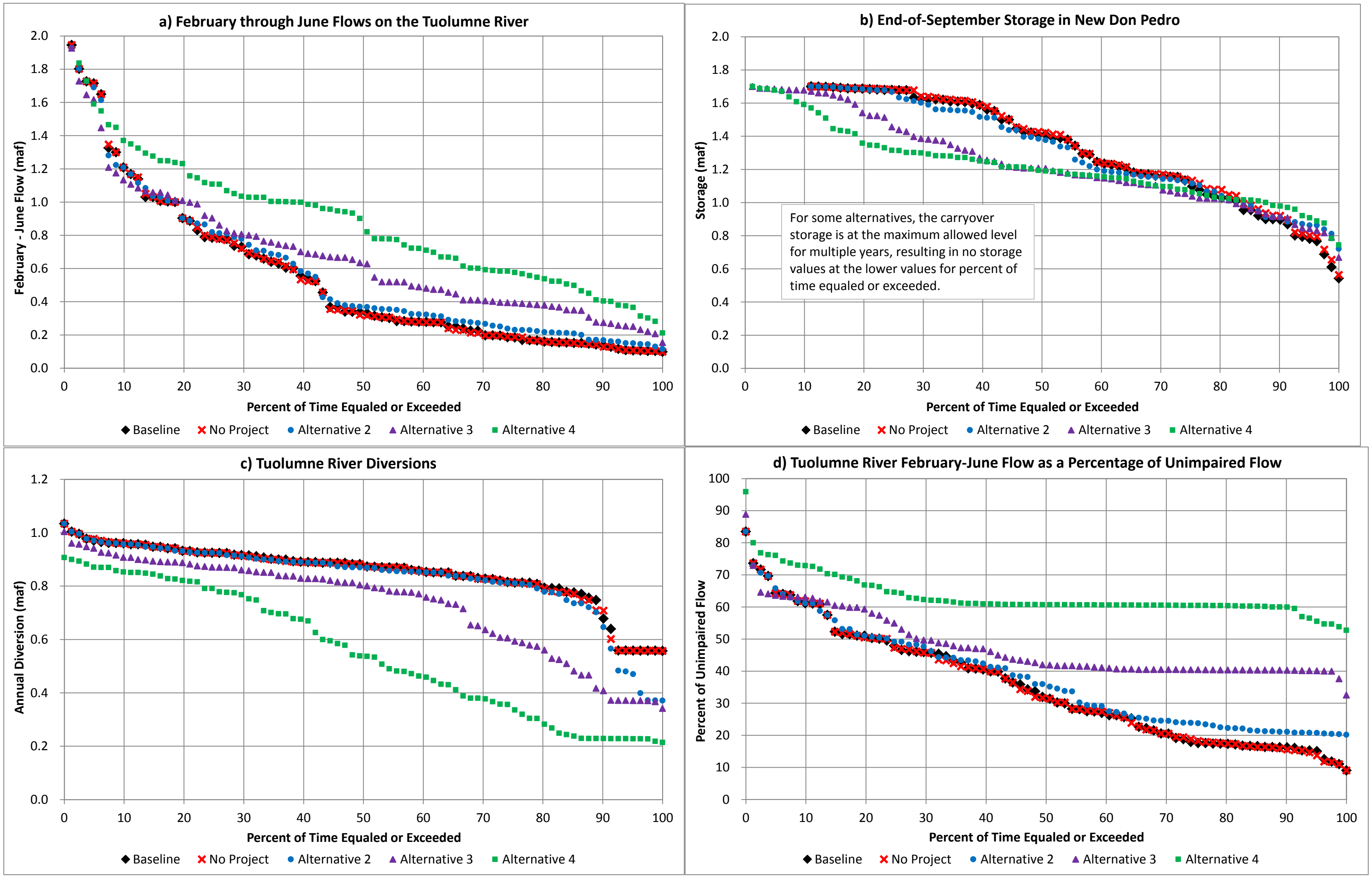


Figure 15-2. Stanislaus River (a) February–June Flow at Ripon, (b) End-of-September (i.e., Carryover) Storage in New Melones Reservoir, (c) Diversions, and (d) February–June Flow as a Percentage of Unimpaired Flow



a) February through June Flows on the Tuolumne River

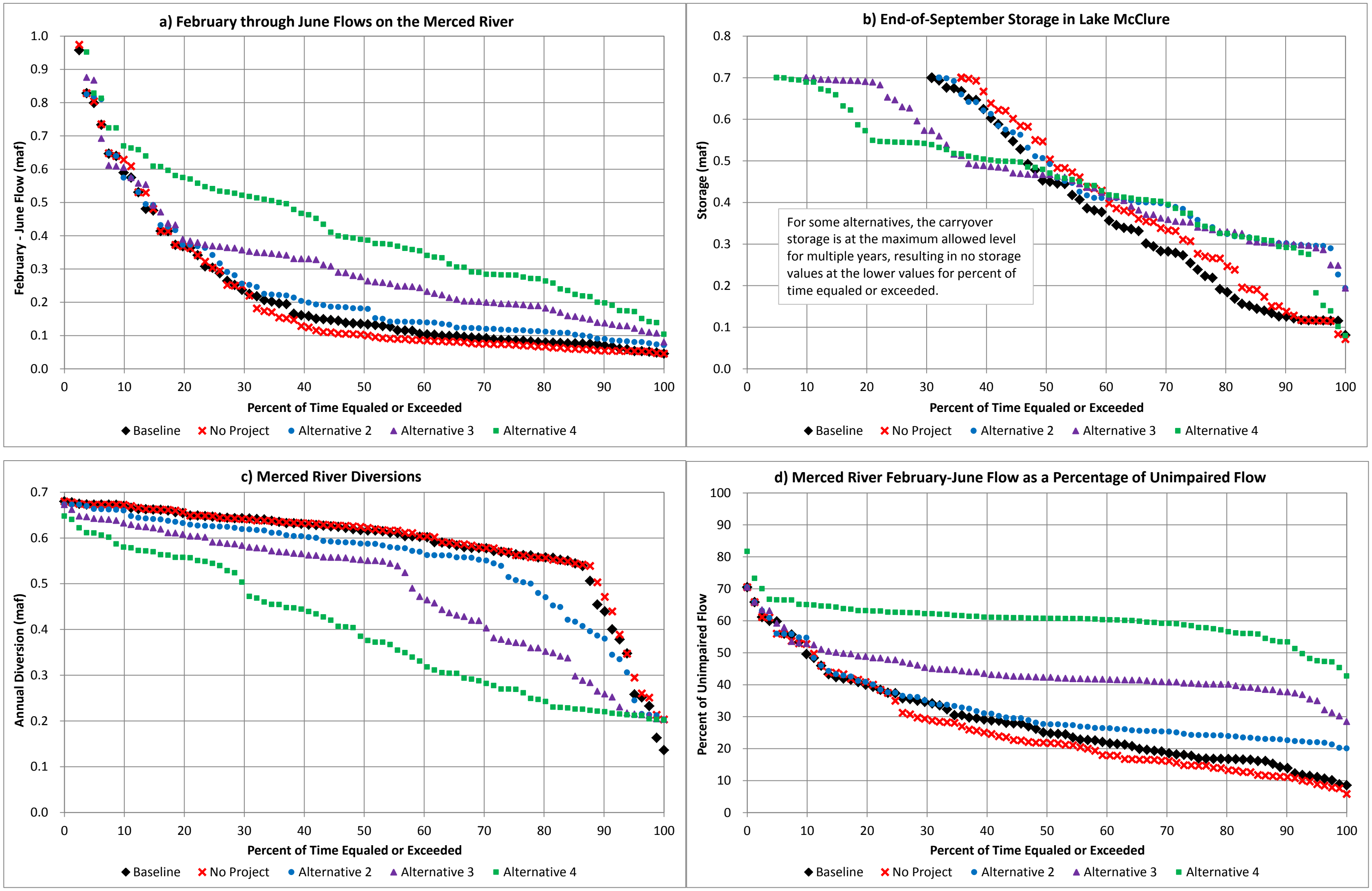
b) End-of-September Storage in New Don Pedro

For some alternatives, the carryover storage is at the maximum allowed level for multiple years, resulting in no storage values at the lower values for percent of time equaled or exceeded.

c) Tuolumne River Diversions

d) Tuolumne River February-June Flow as a Percentage of Unimpaired Flow

Figure 15-3. Tuolumne River (a) February–June Flow at Modesto, (b) End-of-September (i.e., Carryover) Storage in New Don Pedro Reservoir, (c) Diversions, and (d) February–June Flow as a Percentage of Unimpaired Flow



For some alternatives, the carryover storage is at the maximum allowed level for multiple years, resulting in no storage values at the lower values for percent of time equaled or exceeded.

Figure 15-4. Merced River (a) February–June Flow at Stevinson, (b) End-of-September (i.e., Carryover) Storage in Lake McClure, (c) Diversions, and (d) February–June Flow as a Percentage of Unimpaired Flow

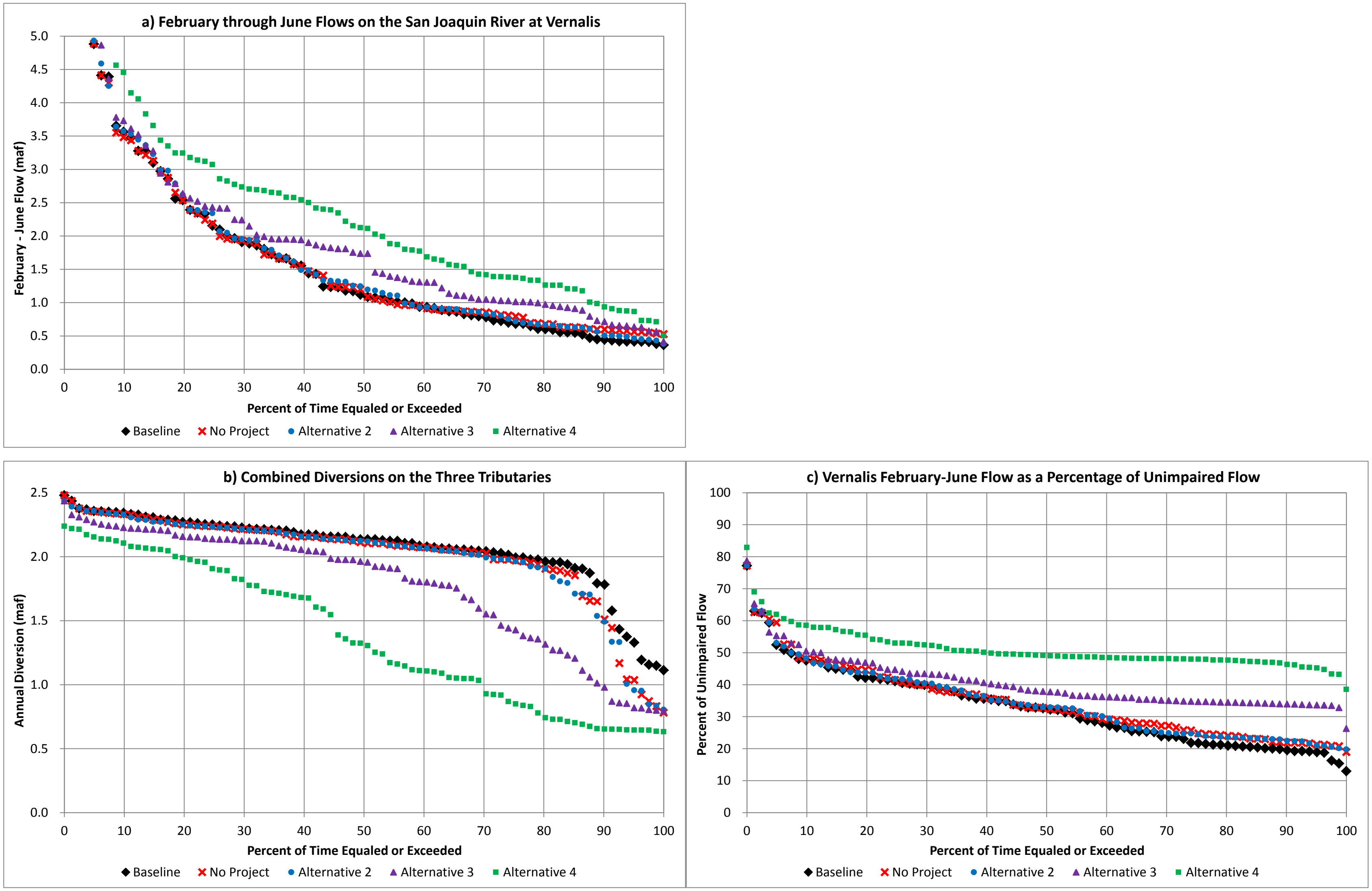


Figure 15-5. San Joaquin River (a) February–June Flow at Vernalis, (b) Combined Diversions from the Three Tributaries (Stanislaus, Tuolumne, and Merced Rivers), and (c) February–June Flow as a Percentage of Unimpaired Flow

15.4 Impacts of the No Project Alternative

The impacts of the No Project Alternative vary among the southern Delta and the three eastside tributaries and reservoirs. These impacts, including cumulative impacts, are summarized in Sections 15.4.1 through 15.4.4. Table 15-2 summarizes the impact determinations for the No Project Alternative.

As described above, the No Project Alternative is the continuation of the current 2006 Bay-Delta Plan as currently implemented into the future. No discretionary approvals would be required to continue operations under the current plan. Since no new project would be approved or carried out in association with the No Project Alternative, potential mitigation is not included in the discussion of impacts below.

15.4.1 Southern Delta

As described above in Section 15.2, *Description of the No Project Alternative*, and Appendix D*, Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, the WSE model includes the flows necessary to meet the Vernalis salinity objectives and the downstream salinity objectives. Because the Vernalis objective would continue to be maintained, water quality at Vernalis and in the southern Delta would not change from baseline. As explained below in Table 15-2, however, it is unlikely that service providers would be able to meet the current 2006 Bay-Delta Plan salinity objectives at all times and that to avoid exceedances of the objectives or permit requirements, they may construct new wastewater treatment facilities or other facilities, or expand such facilities, which could cause significant environmental effects.

15.4.2 Stanislaus River and New Melones Reservoir

The No Project Alternative February–June flows would be greater than baseline and LSJR Alternative 2 in approximately 65 percent of the years on the Stanislaus River. Furthermore, the No Project Alternative flows would be higher than LSJR Alternative 3 in the driest 35 percent of the years and higher than LSJR Alternative 4 in the driest 10 percent of the years (Figure 15-2a). As discussed in Chapters 5–14, the impacts on many flow-dependent resources (e.g., aquatic resources and terrestrial biological resources) associated with the No Project Alternative would generally be similar to those impacts associated with LSJR Alternative 3. However, New Melones Reservoir carryover storage levels would be lower under the No Project Alternative than they would be under baseline. The lower carryover under the No Project Alternative would increase the salmon and steelhead populations' exposure to stressful summer and fall water temperatures in the Stanislaus River relative to baseline.

Surface water diversions would also be lower under the No Project Alternative than under baseline or LSJR Alternative 2 conditions in approximately 50 to 65 percent of the years; diversions would be substantially reduced in approximately 15 percent of the years (Figure 15-2c). In all but the driest 10 percent of the years, more diversions could occur under the No Project Alternative than under LSJR Alternatives 3 and 4 (Figure 15-2c). Overall, the reductions to surface water diversions associated with the No Project Alternative would fall between the impacts associated with LSJR Alternatives 2 and 3.

Reductions in surface water supply deliveries under the No Project Alternative would result in resource impacts similar to those identified for LSJR Alternative 3 in Chapter 11, *Agricultural Resources,* and Chapter 9, *Groundwater Resources*. New Melones Reservoir elevation and carryover storage would be significantly lower under the No Project Alternative than under the baseline or LSJR Alternatives 2 or 3. Additionally, during years with low storage (i.e., storage less than median), New Melones Reservoir storage would be much lower under the No Project Alternative than it would be under LSJR Alternative 4 (Figure 15-2b). No Project Alternative conditions would result in much greater impacts on certain resources (e.g., recreation, cultural resources, and energy) than the conditions described for LSJR Alternatives 2, 3, or 4 in Chapters 5–14.

Impacts on aquatic resources resulting from the No Project Alternative on the Stanislaus River and at New Melones Reservoir were determined to be significant (Table 15-2). Although some of the impacts could be reduced or eliminated by allowing lower flows than those required in the 2006 Bay-Delta Plan the State Water Board is required to comply with adopted or approved water quality control plans (Water Code, § 13247). As such, the State Water Board cannot authorize lower flows than those required by the 2006 Bay-Delta Plan without amending the 2006 Bay-Delta Plan which would be inconsistent with the concept and definition of the No Project Alternative (i.e., continuation of the 2006 Bay-Delta Plan).

15.4.3 Tuolumne River and New Don Pedro Reservoir

The No Project Alternative February–June flows on the Tuolumne River would generally be the same as under baseline (Figure 15-3). Given the minimal difference between the No Project Alternative and baseline, flow impacts on the Tuolumne River would generally not occur. Furthermore, surface water diversions from the Tuolumne River and carryover storage in the New Don Pedro Reservoir (on the Tuolumne River) would be similar to baseline. Therefore, surface water diversion impacts and reservoir storage impacts under the No Project Alternative would not be substantially different from impacts under baseline (Figure 15-3). There would be no impact.

15.4.4 Merced River and Lake McClure

Under the No Project Alternative, carryover storage in Lake McClure on the Merced River would be greater than under baseline because of the reduction in flows otherwise released for VAMP under baseline (Figure 15-4b). Under the No Project Alternative, February–June flows on the Merced River would be less than baseline in more than 50 percent of years (Figure 15-4a), with all the reductions occurring during April and May (Table 15-1), as a result of no VAMP implementation..

Under LSJR Alternatives 2, 3, and 4, the Merced River flows would generally be increasingly higher than they would be under baseline. Therefore, impacts on resources requiring or relying on flows in the Merced River (e.g., aquatic resources) under the No Project Alternative would generally be more severe than those of the LSJR Alternatives 2, 3, and 4, as described in Chapters 5–14. Surface water diversions would be similar to baseline on the Merced River; therefore, surface water diversion impacts would not change substantially from baseline (Figure 15-4c).

In Table 15-2, impacts resulting from the No Project Alternative on the Merced River are determined to be significant

15.4.5 The Extended Plan Area

The State Water Board implemented the No Project Alternative through Decision 1641, and the responsibility for implementation does not extend to the extended plan area. Thus, there are no impacts in that area resulting from the No Project Alternative.

15.5 Cumulative Impacts of the No Project Alternative

Cumulative impacts are defined in the State CEQA Guidelines as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts." (Cal. Code Regs., tit. 14, § 15355.) A cumulative impact from several projects is "the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonable foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time." (Cal. Code Regs., tit. 14, § 15355, subd. (b).)

Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*, includes Table 17-1, a list of past, present, and reasonably foreseeable future projects considered for the cumulative analysis of the impacts of all the alternatives. Present and reasonably foreseeable future projects are projects that are currently under construction, approved for construction, have submitted a request for approval or review by an agency, or are in the final stages of formal planning. These projects were identified by reviewing available information and are summarized in Chapter 17. All past, present, and reasonably foreseeable future projects listed in Chapter 17 are considered, as appropriate, for the No Project Alternative cumulative analysis.

15.5.1 Summary of Potential Cumulative Impacts on Resource Areas

This section summarizes the potential cumulatively considerable effects of the No Project Alternative and potentially significant cumulative impacts. The cumulative impact determinations for the No Project Alternative are based on the changes to the environment described by region in Section 15.4 (more detailed descriptions of the environmental settings for various resources can be found in Chapters 5-14). Impacts resulting from the No Project Alternative, which are described in Table 15-2, are considered in combination with impacts resulting from projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*, Table 17-1, to determine if, in light of the other projects, the impacts of the No Project Alternative are cumulatively considerable or result in a significant cumulative effect. As discussed in Section 15.4, the No Project Alternative would have no impact on Tuolumne River resources or resources affected by New Don Pedro Reservoir operations. Because the No Project Alternative would have no impact on resources within the Tuolumne River Watershed, it would have no cumulative impact in that watershed. The relevant projects listed in Table 17-1 and the No Project Alternative could cause cumulative impacts primarily through changes to flows in the tributaries or in the LSJR, changes in groundwater pumping, or through changes to the operation of the primary rim reservoirs in the plan area.

15.5.1.1 Hydrology and Water Quality

The No Project Alternative, based on the 2006 Bay-Delta Plan, would generally increase flows on the Stanislaus River, have no change on the Tuolumne River, and reduce flows on the Merced River. Because the Vernalis objective would continue to be maintained, water quality at Vernalis and in the southern Delta would not change from baseline and in fact may improve due to increased flows from New Melones. Reduced flow on the Merced River would have a significant impact under the No Project Alternative (see Impact WQ-3 in Table 15-2). The No Project Alternative may result in a cumulatively considerable incremental contribution to a cumulative effect or in a potentially significant cumulative effect on hydrology and water quality in combination with other projects described in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*, that divert water from, or potentially add to or otherwise concentrate pollution in, the Merced River. The cumulative impact on hydrology and water quality is potentially significant.

15.5.1.2 Flooding, Sediment and Erosion

Under the No Project Alternative, flows would be lower than channel capacities on the three tributaries and LSJR as described in Chapter 6, *Flooding, Sediment, and Erosion*. Flows under the No Project Alternative would also not change reservoir flood storage capacity or violate U.S. Army Corps of Engineers flood reservation for the reservoirs in the plan area. Therefore the No Project Alternative would not result in a cumulatively considerable incremental contribution to cumulative impacts and there is no significant cumulative impact related to flooding, sediment, and erosion.

15.5.1.3 Aquatic Resources

The changes to the environment potentially caused by the No Project Alternative (see Table 15-2)—especially changes in flows to the three tributaries, changes in reservoir operations and storage levels, and changes to habitat within the plan area—are potentially similar to the impacts that may be caused by projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*, that affect hydrology and reservoir operations in the watershed. Therefore the No Project Alternative may result in a cumulatively considerable incremental contribution to a cumulative impact or in potentially significant cumulative impact on aquatic resources in combination with other projects. The cumulative impact on aquatic resources is potentially significant.

15.5.1.4 Terrestrial Biological Resources

The changes to the environment potentially caused by the No Project Alternative (see Table 15-2), especially a reduction in flow on the Merced River and changes to riparian habitat within the plan area, are potentially similar to the impacts that may be caused by several of the projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*. Therefore the No Project Alternative could result in cumulatively considerable incremental effects and may result in significant cumulative impacts on terrestrial biological resources.

15.5.1.5 Groundwater Resources

Surface water diversions on the Stanislaus River would be reduced by approximately 9 percent under the No Project Alternative (see Table 15-2). This reduction could lead to an increase in groundwater pumping and in subsidence, which is potentially similar to the impacts that may be caused by several of the projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*. Although the impacts of the No Project Alternative to groundwater are not found to be significant, the No Project Alternative could result in a cumulatively considerable incremental effect on groundwater resources.

15.5.1.6 Recreational Resources and Aesthetics

The No Project Alternative could potentially result in reduced access to boat ramps and potentially degrade the visual quality or character of New Melones Reservoir. The potential reduction in the level of New Melones Reservoir caused by the No Project Alternative (see Table 15-2), is potentially similar to the impacts that may be caused by several of the projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*. Therefore the No Project Alternative could result in cumulatively considerable incremental effects in connection with the effects of other projects and potentially significant cumulative impacts on recreational resources and aesthetics.

15.5.1.7 Agricultural Resources

The No Project Alternative could result in conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses as a result of the reductions in surface water diversions on the Stanislaus River (see Table 15-2). A reduction in diversions on the Stanislaus River may also be caused by projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*. Therefore the No Project Alternative could result in cumulatively considerable incremental effects or in potentially significant cumulative impacts on agricultural resources.

15.5.1.8 Cultural Resources

The end-of-September storage at New Melones Reservoir, under the No Project Alternative, is anticipated to be greatly reduced in over half the years when compared to baseline. This would potentially expose cultural resources and raise the potential for adverse impacts (see Table 15-2). A reduction in storage at New Melones Reservoir may also be caused by several of the projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*. For example, compliance with BOs and salinity control related projects could add to a reduction in storage. Therefore the No Project Alternative could result in cumulatively considerable incremental effects or in a significant cumulative effect in combination with other projects on cultural resources.

15.5.1.9 Service Providers

Based on current effluent discharge concentrations and past exceedances, it is unlikely that existing service providers would be able to meet the current 2006 Bay-Delta Plan salinity objective of 0.7 dS/m from April to August as would be implemented under the No Project Alternative. Additionally, it is unlikely that the Cities of Tracy and Stockton meet the current 2006 Bay-Delta Plan salinity objective of 1.0 dS/m from September–March (see Table 15-2.) There are projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*, that potentially change flow paths and salinity in locations that could affect service providers' ability to comply with the southern Delta salinity objectives in the 2006 Bay-Delta Plan.

Therefore the No Project Alternative could result in cumulatively considerable and incremental effects or potentially significant cumulative impacts on service providers.

15.5.1.10 Energy and Greenhouse Gases

The reduction in diversions on the Stanislaus River could cause a shift to more groundwater pumping and a potential shift from hydropower to non-hydropower energy production. Changes in operations and storage levels at New Melones reservoir could result in reliability impacts on electrical production at the New Melones hydroelectric plant. See Table 15-2 for further details. Similar impacts involving a reduction in flows on the Stanislaus River or impacts on storage levels in New Melones Reservoir may be caused by several of the projects listed in Chapter 17, *Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources*. For example, compliance with BOs and salinity control related projects could add to a reduction in storage. Therefore the No Project Alternative could result in cumulatively considerable incremental effects or in potentially significant cumulative impacts on energy and greenhouse gases.

15.5.2 Additional Resource Areas Considered for Cumulative Impacts under the No Project Alternative

Resource areas were initially evaluated using Appendix B, *State Water Board's Environmental Checklist*. Resource areas that were determined to need further analysis (i.e., impacts are listed as "Potentially Significant Impacts") are evaluated in the resource chapters (Chapters 5–14). However, some resource areas determined to have "Less-than-Significant Impacts" and thus are were only evaluated in Appendix B. These resource areas are discussed below to assess if their incremental impacts are cumulatively considerable when added to the potential impacts of the projects listed in Table 17-1. If an impact does not result in part from the No Project Alternative, it is not discussed.

15.5.2.1 Air Quality

Air quality impacts are discussed in Appendix B, *State Water Board's Environmental Checklist,* Section III, *Air Quality*. In summary, changes in operations at New Melones Reservoir could result in decreased hydropower generation. This loss in hydropower generation may necessitate increased production from other power facilities to offset the loss. Implementation of the No Project Alternative may also result in additional groundwater pumping to replace Stanislaus River diversions. This groundwater pumping is anticipated to be within irrigation service areas and could require additional electrical use. Electric pumps are assumed as the No Project Alternative would be implemented over the long term since they are cheaper and more efficient than diesel pumps over a long term. Reduction in surface diversions from the Stanislaus River could also result in removal of croplands from agricultural production. As discussed in Appendix B, Section III(c), the net effect of would not increase fugitive dust emissions. Implementation of air quality plans would not be affected. There would be no impacts on air quality related to SDWQ from implementation of the No Project Alternative.

The analysis in Appendix B, Section III, does not reveal potential for the No Project Alternative to have an cumulatively considerable incremental effect on air resources. There is no significant cumulative impact.

15.5.2.2 Geology and Soils

Impacts on geology and soils are initially discussed in Appendix B, , *State Water Board's Environmental Checklist,* Section VI, *Geology and Soils*. Detailed analysis of subsidence is included in Chapter 9, *Groundwater*, and erosion is analyzed in Chapter 6, *Flooding, Sediment, and Erosion*. Erosion impacts related to reduced irrigation of irrigated lands are not cumulatively considerable and are less than significant. As discussed in Chapter 11, *Agricultural Resources*, while some agricultural land could be taken out of irrigated agricultural use as a result of the LSJR alternatives (particularly LSJR Alternatives 3 and 4), many of these lands could remain in agricultural use, even if they are not irrigated. Further, they must remain in uses that are compatible with applicable local land use plans, policies or regulations. In addition, the implementation of agricultural practices to address dust control, weed abatement, and revegetation would result in an insubstantial amount of soil erosion or loss of topsoil. None of the other impact areas included in Section VI have impacts caused by any of the project alternatives, including the No Project Alternative. Any other potential cumulative impacts related to subsidence and erosion caused by the No Project Alternative are discussed in Section 15.5.1 under the two topics Flooding, Sediment and Erosion and Groundwater Resources. There would be no impacts on geology and soils specifically related to the SDWQ from implementation of the No Project Alternative.

Other than as discussed in Section 15.5.1 there are no cumulatively considerable impacts on geology and soils caused by the No Project Alternative.

15.5.2.3 Land Use and Planning

Impacts involving land use and planning are initially discussed in Appendix B, *State Water Board's Environmental Checklist,* Section X, *Land Use and Planning*. Two areas within Section X included potentially significant impacts and are analyzed in Chapter 8, *Terrestrial Biological Resources,* and Chapter 11, *Agricultural Resources*. Discussion of cumulative impacts on land use and planning for the No Project Alternative are covered under these two topics in Section 15.5.1. Other areas related to land use and planning do not result in significant cumulative effects.

15.5.2.4 Utilities and Service Systems

Impacts on utilities and service systems are initially discussed in Appendix B, *State Water Board's Environmental Checklist*, Section XVII, *Utilities and Service Systems*. Analysis of the potential for construction of new or expanded water, wastewater or drainage facilities, or any impact on water supplies is covered by Chapter 5, *Surface Hydrology and Water Quality*; Chapter 9, *Groundwater Resources*; and Chapter 13, *Service Providers*. Any cumulative impacts related to utilities and service systems caused by the No Project Alternative are discussed in Section 15.5.1 under the three topics of Chapters 5, 9, and 13. There would be no other impacts on utilities and service systems related to SDWQ from implementation of the No Project Alternative. No further areas related to utilities and service systems require discussion.

Table 15-2. Summary of Impact Determinations for the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)

Impact Statement	Impact Determination	Discussion
Hydrology and Water Quality		
Impact WQ-1: Violate water quality standards by increasing the number of months with EC above the water quality objectives for salinity at Vernalis or southern Delta compliance stations	Less than significant	The No Project Alternative is the continuation of the existing 2006 Bay-Delta Plan, which includes implementation measures to achieve water quality objectives (e.g., the Vernalis and southern Delta EC objectives). Under baseline, the southern Delta EC objectives are not always be attained. Evaluation of monthly flows (Table 15-1) shows that, although a few of the median No Project Alternative flows are less than baseline, Vernalis flows are generally higher under the No Project Alternative, especially during years with low flow (which would be more likely to have EC violations). Because higher flows generally reduce EC, the No Project Alternative would not be expected to cause an increase in the amount of time the water quality objectives for salinity are exceeded at Vernalis or southern Delta compliance stations.-Therefore, increased exceedance of EC objectives at the Vernalis or southern Delta compliance stations would be unlikely to occur under the No Project Alternative. The impact is less than significant.
Impact WQ-2: Substantially degrade water quality by increasing Vernalis or southern Delta salinity (EC) such that agricultural beneficial uses are impaired	Less than significant	For the reasons described in the Impact WQ-1 discussion, the No Project Alternative would be unlikely to cause an increase in EC such that beneficial agricultural uses would be impaired.
Impact WQ-3: Substantially degrade water quality by increasing pollutant concentrations caused by reduced river flows	Significant	Under the No Project Alternative, flows would not be substantially reduced on the Stanislaus, Tuolumne, or LSJR such that contaminant concentrations would increase (Table 15-1). However, on the Merced River, flows under the No Project Alternative would be substantially reduced during April and May compared to baseline, which could result in a significant increase in contaminant concentrations above baseline.
Flooding, Sediment, and Erosion		
Impact FLO-1: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site	Less than significant	Under the No Project Alternative, flows would be lower than channel capacities on the Stanislaus, Tuolumne, and Merced Rivers, as described under LSJR Alternative 4 in Chapter 6, *Flooding, Sediment, and Erosion*. Sediment transport, bank erosion, or meander-bend migration issues and contributions to levee instability would not increase. It is expected that very occasional gravel transport and bank erosion would occur in the upper gravel-bedded reaches of the Stanislaus, Tuolumne, and Merced Rivers. The amount of bank erosion would be limited by flood action levels and existing bank armoring. Impacts would be less than significant.

Impact Statement	Impact Determination	Discussion
Impact FLO-2: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site	Less than significant	Flows would be much lower than channel capacities on the Stanislaus, Tuolumne, and Merced Rivers, as described under LSJR Alternative 4 in Chapter 6, *Flooding, Sediment, and Erosion*. Therefore, significant flooding impacts would not occur outside of floodways. The No Project Alternative would not change reservoir flood storage capacity and would not violate the U.S. Army Corps of Engineers flood reservation; thus, there would be no changes in flood control releases during major flood events. Impacts would be less than significant.
Aquatic Resources		
Impact AQUA-1: Changes in spawning success and habitat availability for warmwater species resulting from changes in reservoir water levels	Significant	Under the No Project Alternative, month-to-month fluctuations in reservoir elevations at New Don Pedro Reservoir would remain similar to the baseline elevations during April-September (the primary spawning, incubation, and early rearing months). Therefore, the availability of warmwater reservoir species habitat and their spawning success would not change at the New Don Pedro Reservoir. However, month-to-month fluctuations at New Melones Reservoir and Lake McClure would increase under the No Project Alternative during April-September, as compared to baseline. Monthly fluctuations greater than or equal to 15 feet (ft) would increase by more than 10% during April-August at New Melones Reservoir and during April at Lake McClure. Therefore, warmwater reservoir species habitat would be significantly altered under the No Project Alternative, which would affect the spawning success of these species.
Impact AQUA-2: Changes in availability of coldwater species reservoir habitat resulting from changes in reservoir storage	Significant	Under the No Project Alternative, End-of-September storage at New Don Pedro and Lake McClure would remain similar to, or be greater than, the storage under baseline elevations. End-of-September storage is not expected to be significantly reduced when compared to baseline. Therefore, the availability of coldwater reservoir species habitat and their spawning success are not expected to change at these reservoirs. However, on average, end-of-September storage at New Melones Reservoir would be reduced by 27%. Therefore, coldwater reservoir species habitat would be significantly altered under the No Project Alternative, which would affect the spawning success of these species.
Impact AQUA-3: Changes in quantity/quality of physical habitat for spawning and rearing resulting from changes in flow	Less than significant	Under the No Project Alternative, flows on the Stanislaus River would increase, while flows on the Tuolumne River would be similar to baseline flows and thus would not reduce the quantity and quality of spawning and rearing habitat. Under the No Project Alternative, the Merced River would experience a relatively large percentage reduction in flows in April and May compared to baseline (Tables D-6). However, predicted changes in flow within this range correspond to only minor increases or decreases in weighted usable area (WUA) and no changes in floodplain inundation area. Therefore, they are not likely to substantially affect the amount of physical habitat for Chinook salmon juvenile rearing and steelhead fry rearing.

Impact Statement	Impact Determination	Discussion
Impact AQUA-4: Changes in exposure of fish to suboptimal water temperatures resulting from changes in reservoir storage and releases	Significant	Under the No Project Alternative, temperatures would not increase on the Tuolumne River because flows and end-of-September storage would be similar to baseline. However, reductions in April and May flows on the Merced River (Table 15-1) would very likely increase temperatures in the river in more than half the years (mostly below normal and dry years), which would increase the frequency of stressful temperatures for Chinook salmon and steelhead rearing and smolt life stages. On the Stanislaus River, higher summer and fall release temperatures associated with reduced storage in New Melones Reservoir are also expected to increase the frequency of stressful water temperatures for Chinook salmon and steelhead adult migration, Chinook salmon spawning and incubation, and steelhead rearing life stages, especially in dry years (Figure 15-2b). Flows and water temperatures in the LSJR would remain largely unchanged relative to baseline (Table 15-1 and Figure 15-5a), which would result in little or no change in exposure of migrating adults and juveniles to stressful water temperatures.
Impact AQUA-5: Changes in exposure to pollutants resulting from changes in flow	Significant	Under the No Project Alternative, the exposure to pollutants resulting from changes in flow would not increase on the Stanislaus or Tuolumne Rivers because flows in these rivers would generally be similar to, or greater than, baseline flows. However, on the Merced River, reductions in April and May flows under the No Project Alternative, especially during dry periods, would very likely increase pollutant exposure to fish compared to the baseline.
Impact AQUA-6: Changes in exposure to suspended sediment and turbidity resulting from changes in flow	Less than significant	As described for LSJR Alternative 4 in Chapter 7, *Aquatic Biological Resources*, and Chapter 6, *Flooding, Sediment and Erosion*, changes in the frequency, duration, and magnitude of increased suspended sediment and turbidity levels would be minor and within the range of historical levels experienced by native fishes and other aquatic species on the three eastside tributaries and the LSJR. Because the No Project Alternative flows during wet years would be less than those described in LSJR Alternative 4 on the Stanislaus River, impacts would be less than those described above. Similar but fewer impacts than those described above would occur on the Tuolumne and Merced Rivers because flows under the No Project Alternative would be similar to or less than baseline flows on these rivers. Therefore, the change in flows would not mobilize more suspended sediment.
Impact AQUA-7: Changes in redd dewatering resulting from flow fluctuations	Less than significant	Under the No Project Alternative, changes in the frequency and magnitude of flow fluctuations resulting in redd dewatering would not occur on the Stanislaus, Tuolumne, and Merced Rivers compared to baseline. Therefore, redd dewatering impacts on Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers would be less than significant.
Impact AQUA-8: Changes in spawning and rearing habitat quality resulting from changes in peak flows	Less than significant	Under the No Project Alternative, substantial changes in the frequency and magnitude of peak flows would not occur compared to LSJR Alternatives 2, 3, and 4 (because the February–June flows at the zero to 10% exceedance level are between those for LSJR Alternatives 2 and 4 [Figure 15-2a]). Therefore, changes in peak flows would not deleteriously affect the frequency and magnitude of gravel mobilization events in the Stanislaus, Tuolumne, and Merced Rivers, and long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality would not occur.

Impact Statement	Impact Determination	Discussion
Impact AQUA-9: Changes in food availability resulting from changes in flow and floodplain inundation	Less than significant	Under the No Project Alternative, no substantial changes in frequency and magnitude of floodplain inundation and associated food web conditions would occur on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR (because there would be no substantial decreases in the highest flows [Table 15-1]). Therefore, no significant impacts on food availability would occur.
Impact AQUA-10: Changes in predation risk resulting from changes in flow and water temperature	Significant	Under the No Project Alternative, predation risk would be unlikely to change on the Tuolumne River because flow, storage, and water temperature would be similar to baseline. However, reductions in flow and associated higher temperatures on the Merced River in April and May would very likely increase predation risk for Chinook salmon and steelhead during rearing and smolt life stages. On the Stanislaus River, higher summer and fall release temperatures associated with reduced storage in New Melones Reservoir would also increase predation risk for juvenile steelhead, especially in dry years (Figure 15-2b). Flows and water temperatures on the LSJR would remain largely unchanged relative to baseline (Table 15-1 and Figure 15-5a), which would result in little or no change in predation risk.
Impact AQUA-11: Changes in disease risk resulting from changes in water temperature	Significant	Under the No Project Alternative, higher summer and fall release temperatures on the Stanislaus River associated with reduced storage in New Melones Reservoir would increase disease risk for Chinook salmon and steelhead adult migration, Chinook salmon spawning and incubation, and steelhead-rearing life stages, especially in dry years (Figure 15-2b). On the Tuolumne River, disease risk would be unlikely to change under the No Project Alternative because flow, storage, and water temperature would be very similar to baseline. However, reductions in flow and associated higher temperatures on the Merced River in April and May would very likely increase disease risk for Chinook salmon and steelhead-rearing and smolt life stages. Flows and water temperatures on the LSJR would remain largely unchanged relative to baseline (Table 15-1 and Figure 15-5a), which would result in little or no change in disease risk.
Impact AQUA-12: Changes in southern Delta and estuarine habitat resulting from changes in SJR inflows and export effects	Less than significant	Under the No Project Alternative, Delta operations would continue to be governed by current restrictions on export pumping rates, inflow/export ratios, and Old Middle River flows to protect listed fish species from direct and indirect impacts of southern Delta operations. Furthermore, during the primary months of concern for fish using the Delta (December–June), changes in exports would be relatively small and less than the changes under LSJR Alternatives 3 and 4, while average monthly Delta outflow would either be similar to or slightly greater than baseline outflow. Therefore, no significant changes in southern Delta and estuarine habitat would occur under the No Project Alternative.

Impact Statement	Impact Determination	Discussion
Terrestrial Biological Resources		
Impact BIO-1: Have a substantial adverse effect on any riparian habitat or other sensitive natural terrestrial communities identified in local or regional plans, policies, or regulations or by California Department of Fish and Wildlife (CDFW) or United States Fish and Wildlife Service (USFWS)	Significant	Fluctuations in reservoir elevations would not be substantially different than those that currently occur. Therefore, the No Project Alternative would not have adverse effects on riparian or other sensitive natural terrestrial communities around the reservoirs. Under the No Project Alternative, flow on the Stanislaus and Tuolumne Rivers and LSJR would not substantially alter riparian habitat or other sensitive natural terrestrial communities because flows on these rivers would be similar to, or greater than, baseline. However, the reduced flow on the Merced River under the No Project Alternative compared to the baseline (Table 15-1) would very likely result in a substantial alteration of riparian habitat or other sensitive natural terrestrial communities on this river, especially during moderate to dry years in the spring growing season (April and May).
Impact BIO-2: Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrologic interruption, or other means	Significant	See Impact BIO-1 discussion.
Impact BIO-3: Facilitate a substantial increase in distribution and abundance of invasive plants or nonnative wildlife that would have a substantial adverse effect on native terrestrial species	Less than significant	As described in Chapter 8, *Terrestrial Biological Resources*, invasive plants and animals already exist throughout the watersheds of the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Although the No Project Alternative could alter vegetation patterns at specific locations, there is no information available to suggest that increased flows on the Stanislaus River or decreased flows on the Merced River would substantially increase the distribution or abundance of invasive plant or nonnative wildlife in a manner that would substantially native terrestrial species
Impact BIO-4: Have a substantial adverse effect, either directly or through habitat modifications, on any terrestrial animal species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW or USFWS	Significant	Impacts on special-status animal species dependent on riparian habitat and impacts on riparian habitat would be similar to those in the ImpactBIO-1 discussion. Under the No Project Alternative, flows on the Stanislaus and Tuolumne Rivers and LSJR would be similar to or greater than baseline. Therefore, the special-status animal species on these rivers would not be substantially affected. However, the reduced flow on the Merced River under the No Project Alternative compared to the baseline (Table 15-1) could result in substantial effects on special-status species reliant on riparian habitat on this river. Therefore, it is expected that special-status animal species on the Merced River would be adversely affected.

Impact Statement	Impact Determination	Discussion
Impact BIO-5: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan or conflict with any local policies or ordinances protecting biological resources	Significant	Under the No Project Alternative, flow on the Stanislaus and Tuolumne Rivers and LSJR would not substantially affect riparian habitat or special-status species. Therefore, the No Project Alternative would not conflict with habitat conservation plans or natural community conservation plans for these rivers. However, the reduced flow on the Merced River under the No Project Alternative compared to baseline could reduce habitat value, which could result in conflicts with habitat conservation plans or natural community plans, which are discussed in Chapter 8, *Terrestrial Biological Resources*.
Groundwater Resources		
Impact GW-1: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge	Less than significant	Groundwater pumping would increase under reduced surface water diversions (i.e., reduced surface water availability); therefore, impacts on groundwater would increase as the percent of reduction in surface water diversions increases. Surface water diversions on the Tuolumne and Merced Rivers would be similar under the No Project Alternative and baseline. Because there would be no change in surface water availability, the groundwater subbasins (Modesto, Turlock, and Extended Merced) served by these rivers would not be affected by the No Project Alternative. However, surface water diversions on the Stanislaus River would be reduced by approximately 9% under the No Project Alternative. As such, the Eastern San Joaquin Subbasin, which is served by the Stanislaus River, would be affected by the reduced surface water diversions. However, as discussed in Chapter 9, *Groundwater Resources*, diversions would be reduced under LSJR Alternative 3 approximately on average by 12%, but the groundwater impacts associated with LSJR Alternative 3 would be less than significant. Because surface water diversions reductions under No Project Alternative (9%) would be less than surface water diversion reductions under LSJR Alternative 3 (12%), the groundwater affects associated with the No Project Alternative would also be less than significant.
Impact GW-2: Cause subsidence as a result of groundwater depletion	Less than significant	As described above for Impact GW-1, the effect of the No Project Alternative on groundwater supplies is expected to be less than significant. As a result, subsidence resulting from the No Project Alternative is also expected to be less than significant.
Recreational Resources and Aesthetics		
Impact REC-1: Substantially physically deteriorate existing recreational facilities on the rivers or at reservoirs	Significant	During the primary recreation months of May–September, the No Project Alternative could slightly shift recreational activities on the Stanislaus River between May and August. Activities suited to higher flows would be slightly shifted to different months and activities suited to lower flows on the Merced River during May would be slightly shifted to other times. (Table 15-1). These shifts would be unlikely to cause significant recreational impacts. Under the No Project Alternative, reservoir elevations at New Don Pedro and Lake McClure would remain similar to baseline. Therefore, substantial physical deterioration at existing recreational facilities at these reservoirs would not occur. However, end-of-September reservoir elevations at New Melones

Impact Statement	Impact Determination	Discussion
		would be greatly reduced compared to baseline, especially during the years with lowest storage (Figure 15-2b). At New Melones Reservoir, boat launches are inoperable when the reservoir elevation is below 850 ft; under the No Project Alternative, the surface of New Melones Reservoir would be below 850 ft approximately 30% of the time in September, which is when recreationists use the reservoir. Therefore, it is anticipated that the No Project Alternative would interfere with the operation of boat ramps which could potentially result in a substantial physically deterioration of facilities at New Melones Reservoir, and thus reduce the use of existing recreation facilities.
Impact REC-2: Substantially degrade the existing visual character or quality of the reservoirs	Significant	Under the No Project Alternative, reservoir elevations at New Don Pedro and Lake McClure would remain relatively constant and would not be substantially reduced compared to baseline. Therefore, substantial degradation of the visual character and quality of area surrounding these reservoirs would not occur. However, summer elevations at New Melones Reservoir would be reduced compared to baseline, especially during years with lowest storage. At the 30%cumulative distribution level, the May–September seasonal average No Project Alternative elevation would be reduced by more than 50 ft, well above the 10-foot level identified in Chapter 10, *Recreational Resources and Aesthetics,* as the criterion for significance. This reduction would substantially degrade the existing visual character or quality of the New Melones Reservoir.
Agricultural Resources		
Impact AG-1: Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use	Significant	Under the No Project Alternative, in areas that receive surface water from the Tuolumne and Merced Rivers, a conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses would not be expected because surface water diversions on the Tuolumne and Merced Rivers would not be significantly reduced. Therefore, it is anticipated that a substantial reduction in crop acreage would not occur in these watersheds, and a conversation of these types of farmland to nonagricultural uses would not occur. The No Project Alternative would result in conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses as a result of the reductions in surface water diversions on the Stanislaus River. The average reduction in surface water diversions of 9% would be slightly greater than the reduction that would occur under LSJR Alternative 2 with adaptive implementation (average reduction of 5% with implementation of adaptive implementation method 1 [i.e., 30%unimpaired flow]) and slightly less than the reduction described for LSJR Alternative 3 (average reduction of 12% at 40% unimpaired flow requirement). As described in Chapter 11, *Agricultural Resources*, LSJR Alternative 3 would result in significant impacts on agricultural resources of the irrigation districts that receive water from the Stanislaus River. Although reductions in surface water supply under the No Project Alternative would be slightly less than those expected under LSJR Alternative 3, significant impacts could occur.

Impact Statement	Impact Determination	Discussion
Impact AG-2: Involve other changes in the existing environment which, due to their location or nature, could result in a conversion of farmland to nonagricultural use	Less than significant	Flows on the Stanislaus River would be increased, which may result in seepage; however, given the small amount of acreage for crops that could be affected, impacts would be less than significant. Similar to conditions under the LSJR alternatives, given the cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distributions from local water suppliers, it is unlikely that dairies, as an agricultural use, would be converted to nonagricultural uses. Impacts would be less than significant.
Impact AG-3: Conflict with existing zoning for agricultural use or a Williamson Act contract	Less than significant	The No Project Alternative would not conflict with existing zoning for agricultural use or Williamson Act contracts because the No Project Alternative would not change zoning. Lands that are under Williamson Act contracts must be maintained in the compatible uses specified in those contracts until non-renewed, canceled, or otherwise withdrawn from contract. Lands that experience a reduction in surface water supply could be dry farmed, rotated, or fallowed, all of which are agricultural activities that are consistent with agricultural zoning and Williamson Act contracts.
Impact AG-4: Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect	Less than significant	The No Project Alternative would not conflict with applicable land use plans, policies, or regulations because while some agricultural land could be taken out of irrigated agricultural use as a result of the No Project Alternative, many of these lands could actually remain in agricultural use, even if they are not irrigated. Furthermore, local agencies have accommodated the conversion and preservation or protection of agricultural lands through various means, including agricultural mitigation programs, agricultural preservation easements, or general plan policies that protect and preserve agricultural land (described in Chapter 11, *Agricultural Resources)*.
Cultural Resources		
Impact CUL-1: Cause a substantial, adverse change in the significance of a historical or archaeological resource	Significant	As discussed in Chapter 12, *Cultural Resources*, changes in river flows are not expected to alter the low potential for significant cultural resources to exist along rivers due to previous natural and anthropogenic disturbances. Given the low potential, impacts would be less than significant on the three eastside tributaries and the LSJR. Reservoir elevations at New Don Pedro and Lake McClure would remain relatively constant when compared to baseline. Therefore, substantial adverse changes in the significance of historical or archeological resources are not expected at these reservoirs. However, the end-of-September storage at New Melones Reservoir is anticipated to be greatly reduced in over half the years when compared to baseline; this would most likely regularly expose cultural resources, which could result in a substantial adverse change to the significance of existing cultural resources if they were disturbed by people or disturbed by another physical method (e.g., light, exposure).

Impact Statement	Impact Determination	Discussion
Impact CUL-2: Disturb any human remains, including those interred outside formal cemeteries	Less than significant	As discussed in Chapter 12, *Cultural Resources*, the potential for human remains to exist within the fluctuation zone of the reservoirs is low. As a result, the changes in New Melones Reservoir elevations under the No Project Alternative would be unlikely to result in the disturbance of human remains. In addition, considering the prior disturbance by agriculture, irrigation practices, mining activities, and development within the riverine floodplains, the change in flows under the No Project Alternative would have an extremely low potential to disturb documented or currently undocumented human remains, including those interred outside formal cemeteries.
Impact CUL-3: Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature	Significant	As described in Chapter 12, *Cultural Resources*, the potential for paleontological resources within and adjacent to the LSJR and the Stanislaus, Tuolumne, and Merced Rivers is considered low due to the depth of occurrence of rock units with high paleontological potential below reworked surficial sediments and Holocene-age floodplain and channel deposits. Buried paleontological resources would be found at soil and rock depth too deep for the rivers to modify or change. Reservoir elevations at New Don Pedro and Lake McClure would remain relatively constant or generally greater, not significantly reduced, when compared to baseline. Therefore, disturbance of unique paleontological resources is not expected at these reservoirs. However, the-end-of September storage at New Melones is anticipated to be greatly reduced in more than half the years compared to baseline, and this could lead to the disturbance of paleontological resources, such as caves.
Service Providers		
Impact SP-1: Require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects	Significant	Under existing conditions, existing wastewater treatment plant dischargers (i.e., Cities of Tracy, Stockton, and Manteca, and Mountain House CSD) are required to comply with National Pollution Discharge Elimination System (NPDES) permit requirements and waste discharge requirements, as described in Section 13.2.3, *Southern Delta,* of Chapter 13, *Service Providers*. However, the southern Delta salinity water quality objectives do not currently apply to the City of Tracy and other municipal dischargers. If the southern Delta salinity objectives are not applied to the municipal dischargers, then the No Project Alternative would not result in a change to the NPDES permit or other discharger requirements; the No Project Alternative would not result in the need to expand existing facilities or infrastructure and would not result in significant environmental effects. However, it is reasonable to expect that the litigation in *City of Tracy v. California State Water Resources Control Board* (discussed in Section 13.2.3) will be resolved in the foreseeable future in a manner that will allow for the application of the Delta salinity objectives to municipal wastewater dischargers. The increase in flow expected under the No Project Alternative would reduce the salinity in the southern Delta at the interior compliance stations and help achieve compliance at these stations. However, based on current effluent discharge concentrations and past violations, it is unlikely that service providers would be able to meet the current 2006 Bay-Delta Plan salinity objective of 0.7 dS/m from April to August. Additionally, it is unlikely that the Cities of Tracy and Stockton would meet the current 2006 Bay-Delta Plan salinity objective of 1.0 dS/m from September–March. Therefore, these service providers, to avoid

Impact Statement	Impact Determination	Discussion
		exceedances of the objectives or permit requirements during some parts of the year may construct new wastewater treatment facilities, or expand existing facilities or infrastructure; construction or operation of the facilities could cause significant environmental effects.
Impact SP-2a: Violate any water quality standards or waste discharge requirements such that drinking water for public wells would be affected	Less than significant	The No Project Alternative could affect drinking water quality in one of two ways. First, the No Project Alternative could cause a reduction in the quality of surface water; however, the No Project Alternative is unlikely to reduce surface drinking water quality because flows at Vernalis would be higher than baseline at the lower flow levels (Table 15-1). In addition, a higher flow at Vernalis is generally associated with better water quality. The reduction in flow and associated potential for increased contaminants along the Lower Merced River is unlikely to cause a substantial reduction in drinking water quality because the baseline Merced River water quality is high enough that degradation would not cause violation of drinking water standards. Second, the No Project Alternative could affect drinking water by causing a reduction in quality of groundwater that is used for drinking water. Reduced groundwater quality could occur if aquifer drawdown causes low-quality water to move toward wells. However, a reduction in the quality of groundwater drinking supply is not expected because the effect of the No Project Alternative on groundwater supplies is expected to be less than significant (as shown in Impact GW-1 under the No Project Alternative).
Impact SP-2b: Violate any water quality standards or waste discharge requirements such that drinking water for domestic wells would be affected	Less than significant	See above.
Impact SP-3: Result in substantial changes to SJR inflows to the Delta such that insufficient water supplies would be available to service providers relying on Central Valley Project (CVP)/State Water Project (SWP) exports	Less than significant	Because average annual inflows to the Delta at Vernalis would increase slightly relative to baseline as a result of the No Project Alternative, exports may also increase. Average annual exports could increase slightly, by 26 TAF/year. Consequently, service providers relying on CVP/SWP exports are unlikely to be negatively affected by the No Project Alternative.
Energy Resources and Greenhouse Gases		
Impact EG-1: Adversely affect the reliability of California's electric grid	Less than significant	Under the No Project Alternative, a moderate reduction in the capacity of the New Melones hydroelectric plant in July and August during dry years could result in minor reliability violations. However, the New Melones hydroelectric plant is located in a Sacramento Municipal Utility District (SMUD) region; SMUD's 2013 Ten-year Transmission Assessment Plan indicates that there are adequate generating resources in the SMUD region to meet load demands and planning reserve margin obligations until 2018. This means that it is likely that minor violations could

Impact Statement	Impact Determination	Discussion
		be alleviated by re-dispatching electrical power from other generating resources available either in a local region or neighboring regions. Therefore, the No Project Alternative would not adversely affect the reliability of California's electric grid, and the impact of New Melones' reduced capacity would be less than significant.
Impact EG-2: Result in inefficient, wasteful, and unnecessary energy consumption	Less than significant	The No Project Alternative could result in additional energy consumption by groundwater pumping. However, because groundwater pumping may be necessary to maintain the water supply irrigation demand, the No Project Alternative would not result in inefficient, wasteful, and unnecessary consumption of energy. Furthermore, it is anticipated that if new groundwater wells were to be installed, they would be energy efficient. The No Project Alternative could result in additional energy generation at other facilities to compensate for a potential loss of hydropower. However, this increased electricity generation is not considered inefficient, wasteful, and unnecessary, as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower.
Impact EG-3: Generate greenhouse gas (GHG) emissions, either directly or indirectly, that have a significant impact on the environment	Significant	The No Project Alternative could result in an increase in groundwater pumping and a potential shift from hydropower to non-hydropower energy production as a result of the expected reduction in surface water diversions and changes to flow on the Stanislaus River. These changes would be expected to generate GHG emissions greater than the threshold of 10,000 metric tons (MT) of GHGs, as described for LSJR Alternative 3 and 4 in Chapter 14, *Energy and Greenhouse Gases*.
Impact EG-4: Conflict with an applicable plan, policy, or Impact regulation adopted for the purposes of reducing the GHG emissions	Significant	Since the No Project Alternative would exceed the 10,000 MT GHG threshold, it would conflict with existing applicable plans, policies or regulations adopted for the purposes of reducing GHG emissions, such as Assembly Bill 32, the California Global Warming Solutions Act.
Impact EG-5: Effect of global climate change on the LSJR and SDWQ alternatives	Less than significant	The State Water Board is required to prepare Water Quality Control Plans (WQCPs). The WQCPs are regularly reviewed to update water quality standards. As a result, the planning process continually accounts for changing conditions related to water quality and water planning, such as climate change. Therefore, the effect of global climate change under the No Project Alternative would be less than significant.

Chapter 16
Evaluation of Other Indirect and Additional Actions

16.1 Introduction

This chapter covers a broad range of topics related to the Lower San Joaquin River (LSJR) Alternatives 2, 3, and 4 and the South Delta Water Quality (SDWQ) Alternatives 2 and 3. It programmatically evaluates other indirect actions and additional actions associated with LSJR Alternatives 2, 3, and 4. The actions include those that the regulated community could take to reduce potential reservoir or water supply effects associated with implementing LSJR Alternatives 2, 3, and 4 with or without adaptive implementation or that would inform the body of scientific information under LSJR Alternatives 2, 3, and 4 with adaptive implementation (i.e., non-flow measures). This chapter also identifies and evaluates the reasonably foreseeable methods of compliance that the regulated community could take to comply with the SDWQ Alternatives 2 and 3 to meet the requirements of Public Resources Code Section 21159 and Section 3777 of the State Water Resources Control Board's (State Water Board's) regulations. It augments the analyses in the preceding chapters relating to the reasonably foreseeable methods of compliance, such as reducing surface water diversions and releasing or bypassing flows at reservoirs in order to comply with the LSJR Alternatives 2, 3, and 4 with or without adaptive implementation. This chapter identifies potentially significant adverse environmental impacts associated with all of these actions and the mitigation measures that would minimize or avoid significant impacts. For the reasonably foreseeable methods of compliance and the other actions, this analysis takes into account a reasonable range of environmental, economic, and technical factors. (Pub. Res. Code, § 21159, subd. (c).)

A project-level analysis is not required for other indirect actions, additional actions, or the reasonably foreseeable methods of compliance. (See, e.g., Id., subd. (d).). Future project-specific actions the State Water Board would take to impose responsibility for implementing the objectives, such as conditioning of water rights through a water rights proceeding or water quality certification under Section 401 of the Clean Water Act through the Federal Energy Regulatory Commission licensing process, would be further analyzed at the time of those actions, undergoing a separate California Environmental Quality Act (CEQA) and economic review. The State Water Board does not under the Porter-Cologne Water Quality Control Act specify the actual means by which other entities choose to comply with the revised water quality objectives. (See, e.g., Cal. Wat. Code, § 13360, subd. (a).) The actual environmental effects will depend on the decisions made by the regulated entities. Any potential environmental impacts depend upon the action, and mitigation selected by or required of the entities implementing site-specific projects. CEQA may require a project-level analysis when actions are undertaken or approved.

This evaluation assumes that all responsible entities will conduct, as appropriate, site-specific environmental analyses to evaluate potentially adverse, project-level environmental impacts, alternatives, and mitigation measures. This evaluation also assumes that responsible entities will design, evaluate, and implement studies, pilot projects, management practices, and controls in compliance with all applicable laws, regulations, ordinances, and formally adopted municipal and/or agency codes, standards, and practices. The specific actions that could be undertaken by an entity to comply with the revised water quality objectives will depend on a number of factors, including feasibility, cost, flexibility, time to implement, location, and likelihood of success.

This chapter is also intended to meet California Water Code (Water Code) Section 13141 requirements. Prior to the implementation of an agricultural water quality control program, the State Water Board must provide an estimate of the total cost of the program together with an identification of potential sources of financing. The SDWQ alternatives are not specifically intended to regulate agriculture; however, this chapter evaluates the associated costs and sources of financing in Sections 16.4.4, *Agricultural Return Flow Salinity Control,* 16.4.5*, South Delta Temporary Barriers,* and 16.4.6, *Low Lift Pumping Stations*.

16.1.1 Chapter Scope and Organization

The chapter is organized primarily by other indirect actions and additional actions that could occur under the LSJR alternatives and the methods of compliance that could occur under the SDWQ alternatives.

Section 16.2, *Lower San Joaquin River Alternatives – Other Indirect Actions*, describes actions that could be undertaken in response to indirect effects of the alternatives (e.g., surface water supply reduction). This chapter presents a suite of reasonably foreseeable actions affected entities may undertake to address possible surface water supply reductions anticipated under LSJR Alternatives 2, 3, and 4 with or without adaptive implementation and analyzes the indirect environmental impacts associated with those actions. While not any one option alone would provide replacement of surface water that may be needed under LSJR Alternatives 2, 3, and 4, with or without adaptive implementation a combination could reduce water supply effects (i.e., less surface water supply to meet various demands). The different types of other indirect actions that could be taken in response to each of the alternatives are unknown; therefore, specific combinations of actions cannot be predictably matched with each alternative. While entities could take one or more of these actions, the combination of actions that entities would take under each alternative is speculative and unknowable. The cost and potential environmental effects of these actions are programmatically evaluated in this chapter using reference projects, standard assumptions regarding the type and potential location of these actions, and impact mechanisms likely to occur as a result of taking these actions. The other indirect actions evaluated in Section 16.2 include:

- Transfer/Sale of Surface Water
- Substitution of Surface Water with Groundwater
- Aquifer Storage and Recovery
- Recycled Water Sources for Water Supply
- In-Delta Diversions
- Water Supply Desalinization
- New Surface Water Supplies

Section 16.3, *Lower San Joaquin Alternatives – Non-Flow Measures*, describes measures that would inform the body of scientific information potentially used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4 with adaptive implementation (i.e., non-flow actions). Not any one measure alone could fully inform the body of scientific information, and as such, a combination could occur. Specific combinations of measures cannot be predictably aligned with each alternative because entities could take one or more of these non-flow measures, the combination of measures that entities would take under each alternative is speculative and unknowable. The cost and potential environmental effects of non-flow measures are programmatically evaluated using reference projects, standard assumptions regarding the type and potential location of these measures, and impact mechanisms likely to occur under these measures. The non-flow measures are grouped into habitat restoration, fish passage, and other actions as follows:

- Habitat Restoration
    - Floodplain and Riparian Habitat Restoration
    - Reduce Vegetation-Disturbing Activities in Floodplains and Floodways
    - Gravel Augmentation
    - Enhance In-Channel Complexity
    - Improve Temperature Conditions
- Fish Passage Improvements
    - Fish Screens (screen unscreened diversions in tributaries and LSJR)
    - Physical Barrier in the Southern Delta
    - Removal or Modification to Human-Made Barriers to Fish Migration
- Other
    - Predatory Fish Control
    - Invasive Aquatic Vegetation Control

Section 16.4, *Southern Delta Water Quality Alternatives – Reasonably Foreseeable Methods of Compliance,* describes reasonably foreseeable methods of compliance measures that could be undertaken by the regulated community to comply with the SDWQ alternatives. The cost and potential environmental effects of these methods of compliance are programmatically evaluated using reference projects, standard assumptions regarding the type and potential location of these measures, and impact mechanisms likely to occur under these measures. The methods of compliance in Section 16.4 include:

- New Source Water Supplies
- Salinity Pretreatment Programs
- Desalination
- Agricultural Return Flow Salinity Control
- Southern Delta Temporary Barriers
- Low Lift Pumping Stations

Section 16.5, *Sources of Funding*, provides a brief summary of the federal and state sources of funding for those actions that could occur under the LSJR or SDWQ alternatives.

Section 16.6, *Potential Mitigation Measures*, summarizes potential mitigation measures that could be applied by other lead agencies and responsible entities to reduce potentially significant impacts identified in the environmental evaluations of Sections 16.2, 16.3, and 16.4. These potential mitigation measures were developed based on a review of similar projects. The scope, scale, and location of a particular project would dictate the need for, and the type of, mitigation. While the particular circumstances and location of a project may result in significant and unavoidable impacts post mitigation, lead agencies and entities may be able to fully mitigate impacts to a less-than-significant level (using one or more of the potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*). In addition, as required by CEQA (State CEQA Guidelines § 15126.2) lead agencies and entities would describe a reasonable range of alternatives based on project-specific conditions and project-specific objectives, and one of the alternatives may, in and of itself reduce significant environmental impacts. The effectiveness of mitigation is contingent upon several other factors, such as those listed below.

- The ability of lead agencies and entities to implement the mitigation.
- The other responsible agencies involved in the project.
- The thresholds lead agencies use to evaluate the impact.
- Site-specific conditions.

Section 16.6 identifies potential and appropriate mitigation measures for each action by resource. Lead agencies or other entities may fully mitigate impacts to a less-than-significant level (using one or more of the potential mitigation measures identified in this section in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*). However, depending on project specifics, implementing mitigation measures may not be fully able to reduce significant impacts, and such impacts may remain significant and unavoidable after mitigation. Therefore, until such time that potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

Section 16.7, *Cumulative Impacts*, provides a broad cumulative impact discussion for all actions identified in this chapter.

16.2 Lower San Joaquin River Alternatives—Other Indirect Actions

This section describes the actions that affected entities may take to develop alternative water supply sources needed to replace surface water that may no longer be available due to implementation of an LSJR alternative and its associated environmental effects. The actions evaluated include:

- Transfer/Sale of Surface Water
- Substitution of Surface Water with Groundwater
- Aquifer Storage and Recovery

- Recycled Water Sources for Water Supply
- In-Delta Diversions
- Water Supply Desalinization
- New Surface Water Supplies

16.2.1 Transfer/Sale of Surface Water

Reductions in surface water diversions are expected as a result of approving an LSJR alternative and the respective program of implementation. One reasonably foreseeable method to augment a water source is to obtain a surface water supply from another party. General costs and potential environmental impacts associated with obtaining surface water supplies are evaluated below along with a more specific discussion of the costs and potential environmental impacts associated with the City and County of San Francisco (CCSF) developing other alternative water supplies.

Cost Evaluation

General

This analysis focuses on the costs to a water purveyor (e.g., irrigation or water supply district) to obtain alternative surface water supplies. For this potential action, it was assumed that a water purveyor would have either purchased water through contracts, transfers, or implementation of Water Code Section 1485.[1] The duration and cost for purchasing water are subject to many factors, but a useful indicator of water prices is the Environmental Water Account (EWA) Spot Price. A summary of EWA contract sales is listed in Table 16-1, *Environmental Water Account Contract Sales 2002–2004*.

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[1] Section 1485 of the Water Code provides that any municipality, governmental agency, or political subdivision that produces disposal water meeting the requirements of the appropriate regional board, and that disposes that water in the San Joaquin River, may file an application to appropriate the same amount of water out of the San Joaquin River or the Sacramento-San Joaquin Delta, downstream.

Table 16-1. Environmental Water Account Contract Sales 2002–2004

Year	Buyer	Seller	Type	Quantity (AF)	Price ($/AF)	2010 Nominal Price ($/AF)
2004	Westlands WD	Widren WD	CVP	2,990	$1,500	$1,741
2004	Westlands WD	Centinella WD	CVP	2,500	$1,400	$1,625
2003	West Kern WD	Berrenda Mesa WD	SWP	6,000	$1,000	$1,161
2003	Lemoore Naval Military Base	Tulare Lake Basin WSD	SWP	5,000	$2,150	$2,496
2003	Coachella Valley WD	Tulare Lake Basin WSD	SWP	9,900	$2,150	$2,496
2002	City of Tracy	Banta Carbona ID	CVP	2,500	$1,000	$1,161
2002	City of Tracy	West Side ID	CVP	5,000	$1,000	$1,161
2002	Zone 7	Tulare Lake Basin WSD	SWP	400	$1,600	$1,858
2002	Zone 7	Belridge WSD	SWP	2,219	$1,500	$1,741
					Average	$1,716

Source: USBR 2006a.

WD = Water District.
ID = Irrigation District.
WSD = Water Storage District.
CVP = Central Valley Project.
SWP = State Water Project.
AF = acre-feet.

A water transfer is a change in the way water was originally allocated. A water transfer may change the place of use, the point(s) of diversion, or the purpose of use. A water transfer cannot increase the amount of water a diverter is permitted to use, nor can it change the season when water is diverted. Water transfers can be temporary (i.e., short-term or temporary transfers of 1 year or less), long-term (more than 1 year), or permanent. Water Code Section 1735 and California Code of Regulations Section 811 et seq. allow a water right permittee, licensee, or adjudicated water right holder to file a petition for a long-term transfer of water involving the change in the point of diversion or place or purpose of use with the State Water Board. A summary of long-term transfers is listed in Table 16-2, *Long Term Transfers 1997–2005*.

Table 16-2. Long-Term Transfers 1997–2005

Year	Buyer	Seller	Water Source	Length	Quantity (AF/y)	Price ($/AF)	2010 Nominal Price
2003	City of Lodi	Woodridge ID	NOD	40 years	6,000	$200	$238
2003	Cities of Tracy, Lathrop, Manteca, and Escalon	South San Joaquin ID	SOD	30 years	43,090	$191	$228
2003	Newhall Land & Farming Co.	Nickel Family	SOD	30 years	1,600	$475	$566
2000	Contra Costa WD	East Contra Costa ID	NOD	Permanent	8,200	$25	$32
2000	Northridge WD	Placer County Water Agency	NOD	15 years	12,000	$435	$565
1997	Metropolitan WD	Arvin Edison WSD	SOD	25 years	50,000	$165	$233
						Average	$310

Source: USBR 2006a.
WD = Water District.
ID = Irrigation District.
WSD = Water Storage District.
AF/y = acre-feet per year.
AF = acre-feet.

Based on the nominal prices shown in Tables 16-1, *Environmental Water Account Contract Sales 2002–2004,* and 16-2, *Long Term Transfers 1997–2005*, a reasonable cost of $1,716 per acre-foot is assumed for an EWA contract sale or $310 per acre-foot for a long-term transfer. These cost estimates are based solely on the projected cost of surface water and do not include capital costs (e.g., conveyance of water from source to point of use), administrative, engineering, or legal costs related to securing the water supply.

CCSF Cost Evaluation

Reductions in surface water diversions could potentially affect CCSF by reducing some portion of their current water supply obtained from the Tuolumne River during a 6-year drought as described in Appendix L, *City and County of San Francisco Analyses*. Under certain LSJR alternatives (i.e., higher unimpaired flow[2] LSJR Alternatives 3 and 4), the San Francisco Public Utilities Commission (SFPUC) may need to obtain water through a water transfer as described in Appendix L. The cost of this water transfer to CCSF depends ultimately on the amount of water needed, purchase price per AF of water, and the duration of the transfer. Details are presented in Appendix L. Annual costs could range between $14 million and $208 million depending on the LSJR alternative (Table L.5-1).

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[2] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

Environmental Evaluation

Summary of Potential Action

A surface water transfer would involve transferring a volume of water from one party to another based upon an agreed upon price and subject to the applicable Water Code and California Code of Regulations requirements where the point of diversion or place or purpose of use of water is proposed to be changed. Only water that is available under applicable operational restrictions, or water rights, can be transferred. Water Code provisions require that surface water transfers must occur (1) without injuring any other legal user of water; (2) without unreasonably affecting fish, wildlife, or other instream beneficial uses; and (3) without unreasonably affecting the overall economy or environment of the county from which the water is being transferred, in the case of transfers using a state or local agency's conveyance facility. Temporary changes of point of diversion, place of use, or purpose of use involving surface water transfers based on post-1914 appropriative[3] water rights must obtain approval from the State Water Board consistent with Water Code Section 1725 et seq. These changes approved under Water Code Section 1725 are exempt from CEQA. Long-term or permanent water transfers would require an analysis of environmental impacts by the agency(ies) selling and transferring water. The State Water Board would be a responsible agency and would review and act on any environmental document. Transfers that require the use of State, regional, or a local public agency's conveyance facilities require the owner of the conveyance facilities (e.g., DWR, USBR) to determine that the transfers will not harm any other legal user of water, will not unreasonably affect fish and wildlife, and will not unreasonably affect the overall economy of the county from which the water is transferred. Both DWR and USBR provide guidance on the requirements and approvals needed to transfer water using their facilities, which generally includes the need for CEQA and/or NEPA documentation and ESA consultation to address fish and wildlife resources.

There are three common types of water transfers: groundwater substitution, cropland idling, and reservoir storage releases (DWR and State Water Board 2015). For water transfers based on groundwater substitution, a water user with surface water diversion rights would forgo diverting surface water and would pump groundwater for the period of the transfer, and in so doing, make the forgone surface water diversions available to a user downstream. Cropland idling water transfers would make water available by reducing the consumptive use of surface water applied for irrigation. This would result in the idling of land that would have been planted during the transfer period in the absence of the transfer. With water transfers involving reservoir storage releases, surface water would be made available for transfer by reservoir storage release when reservoir operations release water in excess of what would be released annually under normal operations, and the water must be released at a time when it can be captured and/or diverted downstream.

Of the three common types of water transfers, those associated with cropland idling or groundwater substitution would be more likely to occur under the LSJR alternatives with or without adaptive implementation within the watersheds of the Stanislaus, Tuolumne, and Merced Rivers. This is because, as the available surface water supplies become more limited, a higher value is placed on the supply. For these two types of transfers, reservoir releases would generally be unchanged. Water transfers involving reservoir storage releases in excess of what would normally be released annually

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[3] Appropriative rights to surface water are rights to use water that is surplus, or unappropriated, to the needs of riparian owners and prior appropriators and prescriptors.

is less likely to occur especially under the LSJR alternatives because most of the water rights associated with existing reservoirs would be fully used and the reservoir releases would occur regardless of the water transfer (i.e., release of excess water would not be a response to the LSJR alternatives). The number and location of surface water transfers that entities would undertake in response to surface water reductions as a result of approving the LSJR alternatives is speculative and unknowable. Individual agencies or entities would decide whether a water transfer would be suitable for their particular circumstances. The water transfer would have the same maximum diversion and the same season of diversion, but would result in a change to the end use of the water (i.e., the terms and conditions of the right).

Water transfers or sales of stored water by agencies or entities can occur in a manner that either contributes to achieving streamflow requirements or potentially exceeds such requirements. For example, in 2013, OID and SSJID released 80 TAF into the Stanislaus River below Goodwin that exceeded the RPA base flow and pulse flow requirements, causing flows to increase by approximately 2,000 cubic feet per second (cfs) over and above the NMFS RPA New Melones dry year type requirement (NOAA Fisheries 2013). This flow release in late April, described as "water rights water," contributed to the pulse flow requirements at Vernalis under D-1641 that would not otherwise have occurred from any other source. Even though USBR, as the operator of the CVP and New Melones, bears responsibility for meeting the objectives, in times of scarcity the stored water in New Melones and elsewhere in the Stanislaus system is claimed by OID and SSJID as senior and contract entitlements, or appropriative water rights. Thus, in the years 2014, 2015, and 2016, USBR filed Temporary Urgency Change Petitions (TUCPs) for modifications of Vernalis flow requirements due to inability to meet the normal requirements. In 2016, OID and SSJID made another water sale of 75 TAF that contributed to streamflow at Vernalis (State Water Board 2016). The sale of transfer water releases to downstream users may meet multiple benefits including contributing to instream flow requirements in transit.

The Water Supply Improvement Program (WSIP) Program Environmental Impact Report (PEIR) evaluated a water transfer between SFPUC and Modesto Irrigation District (MID) and Turlock Irrigation District (TID) for 25 million gallons per day (mgd) during drought years. The final WSIP PEIR reduced the water transfer to 2 mgd during droughts (SFPUC 2008; BAWSCA 2016). While neither 25 mgd nor 2 mgd may be enough to potentially compensate for the potential need under the LSJR alternatives described in Appendix L, *City and County of San Francisco Analyses*, Section L4, *Water Bank Account Modeling*, this information provides context for the potential to transfer water, the types of impacts associated with the transfer of water, and potentially mitigation measures needed to reduce potentially significant impacts. Further, this is an example of a potentially large consumptive use in the extended plan area that could potentially be satisfied though a water transfer. As such, information and potential mitigation measures from the WSIP PEIR is incorporated below, where appropriate, into the discussion of potential environmental effects associated with a water transfer.

Since the program of implementation would result in conditioning water rights and Clean Water Act Section 401 water quality certification conditions to meet the LSJR alternatives, it is not expected that additional intakes or other construction activities would occur for water transfers because the overall volume of water in the watersheds available for surface water diversions would be reduced, and such transfers would likely use existing infrastructure. Because new infrastructure would likely not be constructed, there would be no construction-related environmental effects resulting from such transfers. If new infrastructure was required, potential environmental effects associated with construction would be similar to those impacts discussed for recycled water sources (Section 16.2.4, *Recycled Water Sources for Water Supply*) and new source water supplies (Section 16.4.1, *New Source Water Supplies*), for example. Groundwater wells could potentially be constructed as part of groundwater substitution transfers, and if this were to occur, potential environmental effects associated with construction and operation would be similar to those impacts discussed for substitution of surface water with groundwater (Section 16.2.2, *Substitution of Surface Water with Groundwater*). SFPUC identified various activities that could be undertaken by the selling party of the water transfer (i.e., MID/TID) in the WSIP PEIR, as summarized in Attachment 1 of Appendix H, *Supporting Materials for Chapter 16*. These various activities generally involve the construction or operation of different facilities and these measures are similar to mitigation summarized in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* for impacts discussed in Section 16.2.2, Section 16.2.4, or Section 16.4.1.

Potential Environmental Effects

The type of potential environmental effects, as well as the magnitude and severity of such effects, associated with surface water transfers would be dependent upon the type of surface water transfer(s), the volume of water transferred, the location and duration of the transfer, and use(s) that the water is being transferred to and from. The type, magnitude, and severity of environmental effects would depend on the transferring entity's ability to absorb a reduction in surface water, depending on the use, for a period of time, and the receiving entities particular demand and the duration of the water transfer needed to satisfy the demand.

The WSE modeling results capture conditions under which a sale or transfer of water could occur because the modeling describes the needed amount of water to meet the LSJR alternatives, the potential reduction in surface water supply, and change in reservoir and river conditions under each LSJR alternative. The potential reduction in surface water supply and changes in reservoir and river conditions would occur regardless of if a water transfer is implemented in response to the LSJR alternatives. However, impacts disclosed in other parts of this document could be relevant to a potential water transfer and would capture the types of effects that could occur, depending on the type, location, and duration of the water transfer and the entities involved. For example, if a transfer is made from an irrigation district to a municipality in order to compensate for a surface water supply shortage imposed by the LSJR alternatives, the potential agricultural effects on the irrigation district would fall within those presented in Chapter 11, *Agricultural Resources*, because the analysis in Chapter 11 assigns all reductions in diversions to agriculture. However, if a municipality receives water from an irrigation district, then the municipality may not have a water supply shortage, as discussed in Chapter 13, *Service Providers,* and the effects potentially would be less than those disclosed in Chapter 13. The evaluation of potential environmental effects resulting from new surface water transfers, in response to the LSJR alternatives is general, references information from other parts of this document as needed, and provides examples of the types of effects that may result from water transfers depending on the type and duration of the transfer because the specifics of each transfer cannot be predicted or known at this time.

SFPUC evaluated a water transfer in the WSIP PEIR. The evaluation determined that impacts would be less than significant on the following resources on the Upper Tuolumne River: streamflow and reservoir water levels, geomorphology, surface water quality, surface water supplies, groundwater, fisheries, biological resources, recreational and visual resources, and energy resources. However, mitigation measures, are required to reduce impacts to a less-than-significant level for terrestrial biological resources and are further discussed below (SFPUC 2008, 2012; ESA+Orion Joint Venture 2012).

Agricultural Resources

Surface water transfers based on cropland idling could affect agricultural uses. If cropland is idled, rotationally fallowed, or deficit irrigated (i.e., reduction in irrigation water applied) regardless of the duration, it would still be considered farmland. However, as discussed in Chapter 11, *Agricultural Resources*, lands designated as Prime Farmland, Unique Farmland, Farmland of Statewide Importance, require irrigation water to meet the designation. If irrigation water was reduced due to a longer-term transfer to non-agricultural use, conditions may result similar to those described in Chapter 11, in the plan area. As a result, agricultural impacts associated with cropland idling would be similar to those described in Chapter 11 (Impact AG-1, LSJR Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with or without adaptive implementation) and would be significant. Mitigation measures are proposed in Chapter 11, but impacts would be significant and unavoidable.

Air Quality

Surface water transfers based on groundwater substitution could affect air quality by potentially increasing emissions from an increase in groundwater pumping. Power needed for increased groundwater pumping would come from facilities that currently generate power, such as other renewable generating sources or non-renewable sources. The generation of additional power could result in increased criteria pollutant[4] emissions at other power facilities. However, these power facilities are already built and permitted to emit a maximum amount of criteria pollutants. These facilities are required to offset additional power generation by using pollution credit under existing regulations. Therefore, if additional emissions are generated as a result of an increase in groundwater pumping, these emissions would be generated by facilities that are permitted to do so. The permit requirements would ensure that there would be no net increase in pollutant emissions, and would be consistent with the air quality plans because there would be no net increase due to the facility's permit requirements. Impacts would be less than significant.

Surface water transfers based on cropland idling could affect agricultural uses and could affect air quality. Cropland idling would result in reduced irrigation to existing agricultural lands and could result in less water spread over more acreage (such as increased agricultural irrigation efficiencies) or less water applied to the same crops with a potential reduction in yield. If a reduction in irrigation water resulted in a reduction of agricultural acres actively farmed, or a reduction in the intensity of acreage farmed, air quality would potentially benefit (i.e., reduced smoke, fugitive dust, and equipment exhaust emissions) because there would be a reduction in controlled field burning, soil tilling, crop harvesting, and herbicide/pesticide application. In addition, some lands where irrigation is reduced or removed would still retain crop stubble cover, experience vegetative regrowth, or both. This plant matter would serve to reduce the potential for fugitive dust emissions. In the event that some croplands became and remained unvegetated, fugitive dust emissions could increase from wind-blown dust in those areas. However, in those same areas active agricultural activities and

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[4] The federal and state governments have established ambient air quality standards (AAQSs) for the following criteria pollutants: ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (both particulate matter smaller than 10 microns or less in diameter [PM10] and particulate matter smaller than 2.5 microns or less in diameter [PM2.5]), and lead.

associated emissions that usually occur on a permanent basis, such as crop burning, soil tillage, crop harvesting, and pesticide and herbicide application would be reduced or eliminated. Therefore it is anticipated that the limited amount of fugitive dust emissions associated with unvegetated areas would be significantly less than the potential long-term emissions associated with active agricultural activities. Consequently, impacts would be less than significant.

Biological Resources

In general surface water transfers for groundwater substitution or cropland idling may have small effects on instream flow, but effects on biological resources are unlikely. Reservoir releases for water supply would likely not go beyond what was simulated by the WSE model and disclosed in Chapter 7, *Aquatic Biological Resources* and Chapter 8*, Terrestrial Biological Resources*. The WSE model releases water needed to satisfy water rights. There would be no releases for diversions beyond what would meet full water rights. Releases would only be greater than what is needed for water rights and instream flow requirements when flood-control releases are needed, which are also included in the model. In addition, in acting on petitions related for water transfers involving the change of point of diversion, place of use or purpose of use, the State Water Board would have to find no unreasonable effects on fish and wildlife or other instream beneficial uses to approve the transfer. Therefore, impacts would be expected to be less than significant in the plan area. However, as discussed in the WSIP PEIR, impacts on terrestrial biological resources in the Upper Tuolumne River, and consequently in the extended plan area, as a result of a water transfer would be potentially significant and could be mitigated to a level of less than significant (SFPUC 2008, 2012; ESA+Orion Joint Venture 2012). These mitigation measures include the following and Attachment 1 of Appendix H, *Supporting Materials for Chapter 16* provides descriptions of the mitigation measures for biological resources associated with the water transfer described in the WSIP PEIR.

- Measure 5.3.6-4a Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water
- Measure 5.3.6-4b Fishery Habitat Enhancement
- Measure 5.3.7-2 Controlled Releases to Recharge Groundwater in Streamside Meadows and Other Alluvial Deposits
- Measure 5.3.7-6 Lower Tuolumne River Riparian Habitat Enhancement

Under the LSJR alternatives as described in Appendix L, *City and County of San Francisco Analyses*, there could be a need for a larger water transfer or a longer duration than the one described by the WSIP PEIR. If this were to occur, it is anticipated that the mitigation incorporated into the WSIP PEIR for biological resources would be required and SFPUC can and should implement them. It is possible that additional mitigation to protect biological resources may be necessary, but it is infeasible to identify them until project-specific details like the amount of water and the transfer period are known. Until such time that the potential mitigation measures identified in the WSIP PEIR are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

Surface water transfers based on cropland idling could affect special-status terrestrial species that use the fields for forage, cover, nesting and breeding and the magnitude and severity of the effect would depend on the duration of the transfer and location and extent of cropland. Similar to what is discussed in Chapter 8, *Terrestrial Biological Resources*, while agricultural lands usually provide greater habitat function when compared to urban or industrial land use types, it is expected that potential idling of active agriculture on some lands would not result in a significant adverse effect on special-status and sensitive species. A reduction of active agricultural management, soil tilling, crop harvesting, and herbicide and pesticide application would potentially benefit special-status species by reducing disturbance to potentially suitable habitat and by reducing overall population and habitat fragmentation. Special-status species within the plan area or extended plan area, such as California tiger salamander (*Ambystoma californiense*), San Joaquin kit fox (*Vulpes macrotis mutica*), Swainson's hawk (*Buteo swainsoni*), and various other California native wildlife populations declined as a result of the conversion of California's annual grasslands to agricultural lands (CDFG 2000; Estep 1989; Loredo et al. 1996; Wheeler 2003; CDFW n.d.). Idle lands could prove valuable in providing habitat connectivity and reducing fragmentation for special-status and sensitive species, depending on the location and the amount left idled. The special-status terrestrial wildlife habitat value for idled fields or pasture lands is typically higher than that of active agricultural fields due to the lack of seasonal anthropogenic disturbances and a reduction of the overall vegetative uniformity (USFWS 2009; USFWS 2010; CDFW 2014; Woodbridge 1991). As such, idling with the resultant halting of mechanized agriculture, pesticide and rodenticide application, and anthropogenic disturbance is unlikely to result in a substantial adverse effect on sensitive or special-status species. Furthermore, crops are regularly idled or fallowed for different periods of time throughout the Central Valley, based on weather conditions, crop conditions, crop pricing, water availability, and other variables that factor into farming profitability and decision making. Finally, when agricultural lands are being idled for surface water transfers, landowners are encouraged to cultivate or retain non-irrigated cover crops or natural vegetation for the purpose of providing habitat to waterfowl and other wildlife. (Water Code, § 1018.) Accordingly, cropland idling water transfers would not likely substantially affect special-status terrestrial wildlife and would likely be less than significant.

Hydrology, Water Quality, Geology and Soils

Surface water transfers implemented through cropland idling would be unlikely to substantially affect surface hydrology and surface water quality or result in substantial flooding, sediment, or erosion. While water quality may depend on the timing of the transfer (e.g., lower flows in fall may reduce water quality), surface water transfers typically must be within the same season. As such, the transfer would not be expected to result in a violation of a water quality standard or a degradation of water quality in a river. Water transfers would follow flood control rules and regulations governing releases from reservoirs and as such would not be expected to result in flooding or levee failure as a result of releases during different times of the year from reservoirs because as a result of following flood control rules and regulations channel capacities would not be exceeded. The potential mobilization of sediment and the potential for stream channel alteration and erosion would be considered low given the flows would be within the historic variation. Impacts would be less than significant.

Cropland idling could result in a reduction of acres designated as Prime, Unique, and Farmland of Statewide Importance, but not beyond what is identified in Chapter 11, *Agricultural Resources*. Less-intensive uses such as dryland farming, deficit-irrigation (i.e., reduction in irrigation), and grazing, could take place on lands that are no longer regularly irrigated. In addition, implementation of water conservation measures could allow less water to service more acres. For example, some crops (e.g., alfalfa and pasture) are able to survive under deficit irrigation where only a portion of the crop water demands are met (Putnam et al. 2015a, 2015b). While there could be a decline in yield for these types of crops or a reduction in the full use of pasture, if the full water requirements were continually restricted, they could still potentially remain in agricultural use (Putnam et al. 2015a, 2015b). Finally, even some fallowed lands would be expected to retain crop stubble cover, ultimately experience vegetative regrowth, or both. This root material and regrowth would stabilize soils and serve to reduce the potential for erosion. Currently, there is active agriculture in all three watersheds of the Stanislaus, Tuolumne, and Merced Rivers and along the LSJR. While the level of connectivity of any specific active agricultural acreage to local drainages (i.e., the ability of loose soil to be delivered to a stream) is unknown, soil disturbance associated with active agriculture practices and irrigation practices currently results in disturbance of topsoil and leads to soil erosion, primarily in the plan area. Active agricultural production, such as soil disturbance resulting from soil tillage, the harvesting of crops, and other activities, is a source of erosion and sedimentation associated (Grismer et al. 2006; O'Geen 2006; Singer 2003). Furthermore, even when soil is not being disturbed, agriculture practices often result in bare soil during the rainy season, which is more susceptible to erosion than soil with vegetation. In contrast, if lands are subject to less intensive use due to a reduction in surface water irrigation (e.g., dryland farming, deficit irrigation, or grazing), there would be no change or potentially less sedimentation and erosion. If active agriculture is reduced, there may be an initial period of increased sedimentation or erosion; however, ultimately, it is expected that the reduced tillage and other activities would result in less sedimentation and erosion. As such, reducing existing levels of soil disturbance associated with active agricultural practices and irrigation could reduce erosion and the loss of topsoil. Thus, the potential for soil erosion and sediment delivery to streams would be reduced overall. Consequently, impacts would be less than significant.

Groundwater

Surface water transfers implemented through groundwater substitution could result in a lowering of groundwater levels if groundwater is pumped in substitution for transferred water and could contribute to impacts on groundwater levels or groundwater quality, as described in Chapter 9, *Groundwater Resources*. Chapter 9 assumes that reductions in surface water supply would be replaced with groundwater pumping up to a maximum amount. Based on this analysis, significant impacts would occur on four primary subbasins (Eastern San Joaquin, Turlock, Modesto, and the Extended Merced[5]). Impacts under a water transfer would be based on where pumping currently occurs if it is transferred from one basin to another. As such, a water transfer may not affect total pumping but could affect total recharge. Alternatively, water transfers could affect in-lieu groundwater recharge activities. Under in-lieu recharge programs, water users increase their surface water deliveries in order to temporarily decrease the amount of groundwater they pump from the aquifer. Decreased pumping allows natural recharge to accumulate in the underground aquifer for use during dry years. If water that otherwise would have been used to facilitate in-lieu recharge were to be transferred, then groundwater would still be pumped, which could result in a lowering of groundwater levels. In which case, impacts would be similar to those described in Chapter 9 and would be significant. Mitigation measures are proposed in Chapter 9. While these measures are feasible, they would require action by other entities. As such, until such time that the potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

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[5] The *Extended Merced Basin* is used to reference the Merced Basin and a portion of the Chowchilla Basin, as defined in Chapter 9, *Groundwater Resources*.

Recreation and Aesthetics

Surface water transfers implemented through cropland idling or groundwater substitution is unlikely to affect recreational resources at reservoirs or in or adjacent to rivers because reservoir releases for water supply would occur regardless of the water transfer. Furthermore, while impacts on recreational resources may result from the timing of the transfer (e.g., more recreational uses during the summer), surface water transfers typically must be within the same season and, as such, would limit impacts to that particular season. In general, water transfers would not affect reservoir storage, total diversions, or river flows at the downstream ends of the rivers and, as such, would have limited effects on recreation and aesthetics. However, water transfers could result in a change in the point of diversion, which could affect river flows between the old and new points of diversion, particularly in the extended plan area. For example, recreational and aesthetic resources in the Upper Tuolumne River could be affected as a result of lower river flows beyond what was previously identified in the WSIP PEIR. This could occur because of the potential large consumptive use upstream (e.g., CCSF) and the potential point of diversion at which it may leave the system (Upper Tuolumne). Although the water transfer would be limited to the capacity of existing infrastructure and existing agreements, depending on the magnitude and severity of the change in river levels, impacts could be significant. These types of conditions are less likely to occur on the Stanislaus River given the relatively small consumptive uses upstream of New Melones Reservoir; however, conditions would also depend on the size of the transfer. The State Water Board has authority when considering transfer petitions, to ensure that reservoir levels in the upper watersheds do not cause significant recreation and aesthetic impacts, unless doing so would be inconsistent with applicable laws. Even with this type of mitigation, the impact is considered significant, because the mitigation may not fully mitigate the impact in all situations.

Greenhouse Gases and Energy

Surface water transfers implemented through groundwater substitution could result in groundwater pumping up to existing capacities, which could produce GHGs in exceedance of applicable thresholds, as described in Chapter 14, *Energy and Greenhouse Gases*. The incremental increase in GHG production could be small because in the absence of the transfer, the recipients of the water transfer could potentially pump groundwater to meet their needs, and the water transfer may prevent this pumping. However, the amount of GHGs produced would depend on the details of the transfer, including the amount of water transferred and what would occur in the absence of the transfer (e.g., groundwater pumping by the recipient or alternative action that may not produce GHGs, such as water conservation). If water is transferred such that it results in a change in the point of diversion in the extended plan area, it is possible that there could be a reduction in the amount of water passed through the major hydropower reservoirs. This would likely either be a small volume or could pass through alternative hydropower facilities (e.g., CCSF water could pass through Kirkwood and Moccasin powerhouses), thus minimizing the potential effect to hydropower. Depending on the actions of the parties in the absence of a transfer and the amount of water transferred, the impacts associated with GHGs would be similar to what is described in Chapter 14, and GHG emissions would be significant. Mitigation measures are proposed in Chapter 14; however, the measures are deemed infeasible; as such, impacts would remain significant and unavoidable.

Other Resources

In addition to the resources discussed above, a water transfer implemented through cropland idling and groundwater substitution would be unlikely to substantially affect the following resources:

noise, traffic, cultural resources (significant historical, archeological, or paleontological resources, or human remains), hazards and hazardous materials, population and housing, public services, land use, mineral resources, and utilities and service systems; therefore, there would either be no impact or a less-than-significant impact on these resources. A water transfer would not result in activities that generate noise or traffic. Noise or traffic on local roads could overall decrease if crops are idled temporarily or long term. Surface water transfers would not result in activities that could disturb cultural resources or human remains because ground-disturbing activities would not occur and reservoirs would be operated within their existing capacities and historical elevation variation (similar to what is described in Chapter 12*, Cultural Resources*). An increase in the use, transport, or disposal of hazardous materials would not occur because reservoir operations do not handle, transport, or use hazardous materials and use of hazardous materials (e.g., pesticides/herbicides) would not increase (and may actually decline) as a result of cropland idling because there would either be fewer crops in acreage or less overall production due to potentially less water. Conflicts with public airports or private airstrips or airport management plans would not occur because water transfers would not use these services. Depending on the parties associated with the transfer of water, utilities and service systems may benefit because they may receive water needed to meet demand. A water transfer is not expected to result in an increase in population or growth or the development of housing, or the need for housing, because the water would be used to meet existing demand in a particular service area for a particular duration of time. A water transfer is not expected to physically divide an established community because construction is not expected. The demand for public services (police, fire, parks, other facilities) is expected to remain unchanged because the water being transferred would meet existing demand and, as such, demand and use for public services is not expected to increase. A water transfer would likely be used to meet existing demand for an existing land use, and as such it would likely not result in a conflict with land use and would support an existing use. A water transfer would either use the existing river channel, or off river channels below the reservoir to transfer the water, as such, it would not result in a loss of a mineral resource of value to the region and the residents of the state or of local importance. The mineral resources adjacent to an existing river channel would continue to exist and could be accessed depending on the demand and needs of the area. A water transfer would not affect utilities or service systems such as storm water drains, solid waste disposal, and wastewater treatment capacity or exceed wastewater treatment standards because a water transfer would not require the use of these types of facilities or services.

16.2.2 Substitution of Surface Water with Groundwater

Reductions in surface water diversions are expected as a result of approving the LSJR alternatives and the respective program of implementation. A reasonably foreseeable method to augment a surface water supply is to obtain more water from groundwater resources. This could be achieved by additional pumping from existing wells or the development of new groundwater wells. The costs and potential environmental impacts associated with obtaining more water from groundwater resources are evaluated below.

Cost Evaluation

Groundwater well characteristics are varied throughout the plan area and extended plan area. Major variables in developing groundwater resources include: soil type, intended use, distance to distribution system, design flow, depth to standing water, and pumping plant efficiency (Burt 2011). These variables then determine specific groundwater well characteristics, such as what type of well to construct, what type of pump is needed, and what level of water treatment is needed. Table 16-3, *Typical Well Pump Test Data in the San Joaquin Groundwater Basin*, is a description of typical groundwater well characteristics in the plan area.

Table 16-3. Typical Well Pump Test Data in the San Joaquin Groundwater Basin

Parameter	Value
Average Input Power	56 kW
Average Weighted Power per Acre-foot Pumped	478 kWh per acre-foot
Average Weighted Total Dynamic Head	260 feet
Average Weighted Flow Rate	1,099 gallons per minute
Average Weighted Depth from Surface to Standing Water Level	189 feet
Average Weighted Motor Horsepower	116 horsepower
Average Weighted Overall Pumping Plant Efficiency	57%

Source: Table is reproduced from data presented by Burt 2011.

Note: All weighted values are weighted by input power (kW).

kW = kilowatt.

kWh = kilowatt hour.

Groundwater well operations and maintenance costs are highly variable and depend on pump efficiency, depth of the water, cost of electricity, volumetric flow, cost of maintenance, proximity to water distribution system, and staff needed to maintain equipment and facilities. The ideal scenario is one with very efficient pumps (above 70 percent efficiency), that require little maintenance, and that pump from relatively shallow wells.

One of the dominant cost categories in the operations and maintenance budget for groundwater wells is the cost for electricity. Energy costs are published annually by the California Public Utilities Commission (CPUC). Historical electric rates are shown in Table 16-4, *Pacific Gas & Electric Average Bundled Rates by Class 2007–2011*.

Table 16-4. Pacific Gas & Electric Average Bundled Rates by Class 2007–2011

	Cents per kWh					
Rate Payer Class	2007	2008	2009	2010	2011	Average
Agricultural	12.4	13.2	14.2	14.2	14.6	13.7
Small/Medium Commercial	15.1	14.7	16.4	16.9	16.8	16.0
Large Commercial and Industrial	11.5	10.7	12.4	12.6	12.6	12.0

Source: CPUC 2011.

Note: Table is a summary of data presented by the California Public Utilities Commission. Data omitted was for non-pertinent ratepayer classes (e.g., residential) and data from 2000 to 2006.

kWh = kilowatt hour.

To estimate average electricity costs, average weighted power per AF pumped from Table 16-3, *Typical Well Pump Test Data in the San Joaquin Groundwater Basin*, is multiplied by the average cost per kilowatt hour (kWh) shown in Table 16-4, *Pacific Gas & Electric Average Bundled Rates by Class 2007–2011.*[6] Based on information presented in these tables, it is reasonably estimated that groundwater pumping electrical costs in the plan area are between $57.36 and $76.48 per AF. This estimate is for a groundwater well with the characteristics in Table 16-3, *Typical Well Pump Test Data in the San Joaquin Groundwater Basin*. However, pumps that are more efficient or pump from shallower wells would have a lower electrical cost per AF. Conversely, less efficient pumps and deeper wells would have a higher electrical cost per AF.

Energy costs could represent 50–75 percent of a water utility's budget (Flex Your Power 2012). Using the upper end electricity cost calculated above ($76.48 per AF), the total operations and maintenance cost of a groundwater project could be estimated between $101.97 and $152.96 per AF annually.

As part of the California Water Plan Update 1994, the California Department of Water Resources (DWR) analyzed agricultural groundwater production costs. This analysis described the average costs at specific locations within a region, including capital, operations, maintenance, and replacement costs. These costs are presented in Table 16-5, *Typical Agricultural Groundwater Production Costs by Hydrologic Region*, in 1992 dollars and calculated 2010 dollars (DWR 1994).

Table 16-5. Typical Agricultural Groundwater Production Costs by Hydrologic Region

Groundwater Basin	1992 Groundwater Costs ($/AF)	2010 Groundwater Costs ($/AF)
San Joaquin	$30–$40	$48–$64
Tulare Lake	$40–$80	$64–$127
Sacramento River	$30–$60	$48–$95

Source: DWR 1994.

Note: From DWR Bulletin 160-93 Table 7-10, California Water Plan Update Oct 1994; costs normalized by State Water Board staff.

AF = acre-feet.

Agricultural and municipal groundwater production costs are not the same. Costs to municipal water users would likely be higher due to treatment, permitting, overhead, and labor costs not normally realized by agricultural users. Table 16-6, *Example New Groundwater Well Projects Funded by the California Department of Water Resources Integrated Regional Water Management Implementation Grant Program, Phase 1*, presents a summary of representative groundwater projects funded by the Proposition 84 Integrated Regional Water Management Implementation Grant Program, Phase 1 (IRWM). These projects generally construct a new groundwater well or wells, and the associated facilities to connect the well(s) to a municipal water distribution system. Cost estimates also include soft costs, such as the cost of planning, design, permitting, and administration. These projects were awarded funding in 2011, but costs are represented in 2009 dollars (DWR 2011a).

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[6] As described in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* average groundwater pumping costs vary. An average energy price of $0.189/kWh, is used in the Statewide Agricultural Production (SWAP) model (CH2MHill 2012). Many irrigation districts have hydropower projects and receive discounted power.

Table 16-6. Example New Groundwater Well Projects Funded by the California Department of Water Resources Integrated Regional Water Management Implementation Grant Program, Phase 1

Applicant	Project	Project Cost	Operations & Maintenance Budget ($/year)	Production (AF/y)	20-Year Amortized Cost ($/AF/y)
City of Sacramento	E.A. Fairbairn Groundwater Well Project[a]	$1,578,454	$240,000	2,250	$142
Sacramento Suburban Water District	Coyle Avenue and Roseview Park Pump Stations and Treatment Systems Project[b]	$5,735,537	$68,000	5,750	$62

Source: DWR 2011a.

Note: All projects generally construct new groundwater wells and associated pumps and facilities to pump groundwater.

AF/y = acre-feet per year.

[a] As part of the E.A. Fairbairn Groundwater Well Project, the City of Sacramento proposes to construct one well, which would operate 65 percent of the time in an average water year and produce 1,462 AF/y. In dry years the well would operate 100 percent of the time, producing 2,250 AF/y, and in wet years, well operation would be reduced to 15 percent of the time, producing 337 AF/y (DWR 2011a).

[b] Sacramento Suburban Water District's project proposes to construct two wells (one 2,250 AF/y and one 3,500 AF/y well).

Within the plan area and extended plan area, there are many water suppliers that rely on groundwater to meet water demands. The City of Merced relies completely on groundwater to meet municipal water demands. The City of Merced operates 22 active groundwater wells, 340 miles of distribution pipelines, 4 major water storage tanks, and supplies 7 billion gallons of water to its customers annually. The City of Merced's 2010–2011 budget for water services and infrastructure was $41,621,784 (City of Merced 2010). Based on the entire operating budget and total groundwater production, this equates to $1,937.50 per AF.

The City of Merced's groundwater pumping costs represent the high end of costs for this potential action because these costs include water treatment, maintenance of a substantial transmission system, funding a significant capital improvement plan, and 29 staff to plan, manage, operate, and maintain the entire water infrastructure for a city of more than 80,000 people (City of Merced 2010). Smaller water systems, such as those operated by smaller water suppliers and agricultural users, are likely to incur less cost per AF produced.

In areas above the rim dams[7] most groundwater originates from cracks or fractures in hard rocks, such as granite, greenstone, and basalt (County of Mariposa 2014). For those attempting to create new wells the location of fractures and the quantity and quality of groundwater within the fractures underlying any particular parcel is unknown (County of Mariposa 2014). Typical groundwater wells

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[7] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

in the upper watersheds of the Sierra Nevada are drilled to depths of between 150 and 600 feet (ft), include a solid casing or a seal from the land surface to a depth of between 50 and 200 ft, and are either open or have a perforated casing below that depth (Fram and Belitz 2014). Half of all hard rock wells yield 10 gallons per minute (GPM) or less, which is only enough for individual domestic supplies, but if conditions are good they can produce hundreds of GPM (DWR 2011b).

In response to the 2013–2015 drought many additional wells were drilled within the areas above the rim dams of the eastside tributaries. New private well costs were reported ranging from $10,000 to $20,000 (Petersen 2014, James 2015). In 2014 the Lake Don Pedro Community Services District (CSD) proposed construction of a new 72 GPM groundwater well as part of the Yosemite-Mariposa Integrated Regional Water Management Plan. Lake Don Pedro CSD estimated that the well would cost $125,000 to construct and an additional $4,000 annually for maintenance (Lake Don Pedro CSD 2014). In 2015, as the drought worsened, Lake Don Pedro CSD planned construction of three more 100 GPM wells at about $400,000 each, not including potential water treatment costs up to $150,000 per well (Sierra Sun Times 2015). In addition, the Lake Don Pedro CSD reported on June 7, 2016 that another new well had been completed with a total cost of $475,000, mostly funded by grants from DWR and State Water Board (Lake Don Pedro CSD 2016). In Tuolumne County the Twain Harte CSD constructed a 50 GPM well to improve water supply reliability. The well was fully funded by a State Water Board emergency drought grant and the final project cost was $250,000 (Twain Harte CSD 2015).

Environmental Evaluation

Summary of Potential Action

While it is unknown exactly how surface water users could respond to a reduction in their surface water supply as a result of a program of implementation which could limit their water rights, it is reasonable to assume that some amount of groundwater would replace surface water use. Currently, irrigation districts pump groundwater during dry years to supplement surface water diversions. Additionally, some municipalities in the watersheds primarily rely on groundwater and augment their supplies with surface water.

It is possible that some irrigators/irrigation districts and some municipalities may need to construct and operate new groundwater wells. New agricultural or municipal groundwater wells and associated distribution systems could be constructed and operated by existing irrigation districts (e.g., South San Joaquin Irrigation District, Oakdale Irrigation District, Modesto Irrigation District, Turlock Irrigation District, Merced Irrigation District), water districts (e.g., Stockton East Water District, City of Merced, City of Modesto, Stevinson Water District), or individual agricultural users. Both irrigation districts and water districts provide water to agricultural users for irrigation and municipal users for domestic, municipal, and industrial purposes. It is not possible to estimate the location, timing of construction, details of operation, and number of groundwater wells and associated distribution system that may be constructed in the future. However, it is reasonable to assume that new agricultural groundwater wells would be constructed close to the location of use (e.g., agricultural fields). It is likely these would be operated using electricity from the grid, though some of them could use fossil fuel powered generators. It is assumed new municipal groundwater wells would be located within urban or suburban areas to be located near the existing municipal distribution system. They would be operated using electricity and would be required to follow existing drinking water treatment standards. Some new municipal wells may need well head treatment to comply with state and federal drinking water standards. This type of treatment typically would occur at the wellhead site.

Potential Environmental Effects

Construction of either agricultural groundwater wells for primarily agricultural purposes or municipal groundwater wells for domestic, industrial, and commercial purposes may result in minor, temporary, and localized effects typically associated with construction activities, including dust and air quality effects and ground disturbance. Wells would most likely be placed in areas that are already disturbed through agricultural practices or urban development, so the potential natural and cultural resources (significant historical, archeological, or paleontological resources) effects could be minimal.

It is reasonable to assume that any new wells would be professionally installed by municipal water purveyors or agricultural users using best management practices (BMPs) typically used in drilling new wells, minimizing potential cross-connection of aquifers and related potential effects associated with water quality and hazardous materials. Wells are commonly constructed and operated in both rural and urban areas, are a common land use, and are part of the landscape. Well construction may result in minor increases of electricity and fossil fuel use; however, these increases would largely be offset by a reduction in surface water diversions and the associated pumping costs.

Table 16-7, *Potential Environmental Effects of Substituting Surface Water with Groundwater*, summarizes the potential environmental effects associated with new groundwater supplies. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of new groundwater supplies and is referenced in Table 16-7 where appropriate.

Table 16-7. Potential Environmental Effects of Substituting Surface Water with Groundwater

Potential Environmental Effects of Substituting Surface Water with Groundwater	
Resource	Discussion
Aesthetics	• Construction and operation of new agricultural wells would not be expected to significantly affect the visual character or quality of agricultural areas in the plan area or extended plan area because groundwater wells currently exist in agricultural areas and are part of the visual character of agricultural areas. Wells are generally low to the ground and are typically not located in areas where there are sensitive receptors (e.g., recreationists), which would be affected by changes in views or visual character and quality. Agricultural wells are not expected to have operational lights that would generate substantial light or glare. Impacts would be less than significant. • Construction and operation of new municipal groundwater wells would not be expected to significantly affect the visual character or quality of municipal areas in the plan area or extended plan area because groundwater wells are generally low to the ground, may be contained within a small structure to protect above-ground piping infrastructure, and would likely be fenced for security, which could prevent direct views. Operation of new municipal groundwater wells may have operational and safety lights. Impacts would depend on the location of sensitive receptors to potential lighting; however, lights would be expected to follow lighting guidelines and lighting plans of local jurisdictions approving the construction and operation of the wells. Table 16-38 identifies potential mitigation measures lead agencies (e.g., municipal water purveyors) can and should implement to reduce potentially significant environmental effects associated with lighting. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the potential location of possible sensitive receptors and the ability of reducing light and glare.
Agriculture and Forestry Resources	• Construction of new agricultural groundwater wells would result in ground disturbance of agricultural land in and immediately around the well site, and accordingly could result in the temporary impact on Prime or Unique Farmland, or Farmland of Statewide Importance. However, because agricultural groundwater wells would be installed to support the continued use of the land for agriculture, it is likely that the land immediately surrounding the new agricultural well would be returned to agricultural use once the well was constructed. Impacts would be less than significant. • Operation of new agricultural groundwater wells would occur on agricultural land (potentially including Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) and would be used to support the continued agricultural use of the land by supplying irrigation water. The groundwater wells would be expected occupy less than one quarter of an acre per well, and therefore, they would not substantially reduce the area available for crop production. Impacts would be less than significant. • Limited forestry resources occur in the plan area. Although extensive forestry resources occur in the extended plan area (e.g., Stanislaus National Forest), it is expected that construction and operation of new agricultural groundwater wells would occur on land zoned for agriculture and not on land zoned for forest land or timberland.

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	Therefore, construction and operation of new agricultural wells would not be expected to result in conflicts with existing zoning for, or cause rezoning of, forest land or timberland, or result in the loss of forest land or conversion of forest land to non-forest use. Impacts would be less than significant. • Construction and operation of new municipal groundwater wells would not be expected to be located on lands used for agriculture, but rather would be located close to the urban and suburban uses they supply and within proximity to existing water supply infrastructure. If new municipal groundwater wells were located on agricultural land (including Prime Farmland, Unique Farmland, or Farmland of Statewide Importance), they would be located on relatively small areas of land, which would represent only a very small fraction of the existing agricultural land. Impacts would be less than significant. • Construction and operation of new municipal groundwater wells would likely not occur on lands zoned for forest or timberlands because the wells would necessarily be located within proximity to urban and suburban areas and existing water supply infrastructure. Accordingly, the construction and operation of new municipal groundwater wells would not be expected to result in the loss of forest land or conversion of forest land to non-forest use. Impacts would be less than significant.
Air Quality	• The plan area is located in the San Joaquin Valley Air Basin (SJVAB) and partially located in the Mountain Counties Air Basin (MCAB). The extended plan area is also partially located in the SJVAB, MCAB, and the Great Basin Valleys Air Basin (GBVAB). New agricultural or municipal groundwater wells could be located in any or all of these air basins, which generally cover San Joaquin, Stanislaus, Merced, Mariposa, Tuolumne, Calaveras, Alpine, and Madera Counties, because the water supplied by the wells would support agricultural and municipal uses in these areas. The plan area and extended plan area occur within the jurisdictions of the San Joaquin Valley Air Pollution Control District (SJVAPCD), Calaveras County Air Pollution Control District (CCAPCD), the Great Basin Unified Air Pollution Control District (GBUAPCD), Mariposa County Air Pollution Control District (MCAPCD), and Tuolumne County Air Pollution Control District (TCAPCD). SJVAPCD's published guidelines, *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002) do not require the quantification of construction emissions. Rather, the guidelines require implementation of effective and comprehensive feasible control measures to reduce PM10[8] emissions (SJVAPCD 2002). SJVAPCD considers PM10 emissions to be the greatest pollutant of concern when assessing construction-related air quality impacts and has determined that compliance with its Regulation VIII, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), constitutes sufficient mitigation to reduce construction-related PM10 emissions to less-than-significant levels and minimize adverse air quality effects. All construction projects must abide by Regulation VIII. This would include the implementation of a Dust Control Plan (Siong pers. comm.). Further consultation with SJVAPCD staff indicates that though explicit thresholds for construction-related emissions of ozone precursors are not enumerated in the *Guide for Assessing and Mitigating Air Quality Impacts*, SJVAPCD considers a significant impact to occur when construction

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[8] PM10 standard includes particulate matter with a diameter of 10 micrometers (microns) or less.

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	or operational emissions of reactive organic gases (ROG) or nitrogen oxides (NO_X) exceed 10 tons per year or if PM10 or PM2.5[9] emissions exceed 15 tons per year (Siong pers. comm.). For project components within the boundaries of the CCAPCD, a significant impact would occur if project emissions are greater than 150 pounds per day for ROG, NO_X, or PM10 or less, in either the construction or operational periods. No thresholds for other criteria pollutants, their precursors, or GHGs have been established by the CCAPCD. The GBUAPCD does not have adopted quantitative thresholds of significance for criteria pollutants for proposed projects for the purposes of CEQA, although thresholds from neighboring air districts (e.g., CCAPCD, TCAPCD, SJVAPCD) may be used to evaluate impacts within the GBUAPCD. For construction impacts, the GBUAPCD requires that project proponents adopt comprehensive mitigation measures to mitigate fugitive dust impacts. For emissions associated with the operation of stationary sources, the GBUAPCD considers stationary emissions to be less than significant if they are exempt from Rule 202 pursuant to Rule 209-A(B)(2). Rule 209-A identifies emission limits of 250 pounds per day for ROG, NO_X, sulfur oxides (SO_X), and particulate matter.[10] For project components within the boundaries of the MCAPCD, a significant impact would occur if project operational emissions are greater than 100 tons per year for ROG, NO_X, CO, SO_X, PM10, and PM2.5.[11] For project components within the boundaries of the TCAPCD, a significant impact would occur if project emissions are greater than 100 tons per year or 1,000 pounds per day for ROG, NO_X, CO, SO_X, and PM10. • Construction of new agricultural or municipal groundwater wells would likely result in emissions associated with construction equipment and construction vehicles, as well as fugitive dust emissions from ground disturbance. The quantity, duration, and the intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be “diluted” relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since construction of groundwater wells does not require lengthy construction activities, the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the applicable air pollution control districts’ (APCDs)’ regulations and established thresholds. Lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that

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[9] PM2.5 standard includes particulate matter with a diameter of 2.5 micrometers (microns) or less.

[10] For existing stationary sources that have net emissions of 250 pounds or more per day of particulate matter measured as total suspended particulate, a net increase in emissions of 80 or more pounds per day of PM10 due to modifications requires the use of best available control technology.

[11] No construction-period thresholds have been established by MCAPCD.

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	impacts could be mitigated to less than significant once mitigation measures were implemented given the relatively short term of construction and the limited use of equipment. • New municipal groundwater wells would likely use electric power to operate the pumps because of their expected locations in urban and suburban areas and the expected location in close proximity to existing water supply infrastructure. The need for additional energy to operate additional agricultural well pumps could result in increased criteria pollutant emissions at other power facilities. However, the power facilities that would compensate for the additional power are already built and permitted to emit a maximum amount of criteria pollutants. These facilities are required to offset additional power generation by the use of pollution credit. Therefore, if additional emissions are generated, they would be generated by facilities that are permitted to do so. Impacts would be less than significant. • They may use fossil-fuel powered back-up generators during intermittent emergency situations and their cumulative operation could result in exceedances of the thresholds for SJVAPCD, CCAPCD, GBUAPCD, MCAPCD, and TCAPCD. The potential increase in criteria pollutant emissions could be potentially offset by reductions in surface water diversions that often require the use of electric or fuel pumps to lift water into canals. Operations for new groundwater wells would include facility inspection and maintenance activities and are expected to require similar or less inspection and maintenance than existing municipal groundwater wells. It is expected that new groundwater wells would generally require very little maintenance once construction is completed and only as-needed. Emissions generated during operations would be minimal and would comply with applicable emissions thresholds for SJVAPCD, CCAPCD, GBUAPCD, MCAPCD, and TCAPCD. Impacts would be less than significant. • Operation of new agricultural wells is expected to use electric power to operate the pumps because it is a more economical source of power when compared to fossil fuel power generation; however, if fossil fuel powered generators are used to run the groundwater well pumps, there would be air quality pollutant emissions associated with burning fossil fuels (e.g., PM10) and their cumulative operation could result in exceedances of the thresholds for SJVAPCD, CCAPCD, GBUAPCD, MCAPCD, and TCAPCD. For electric wells, the need for additional energy to operate additional agricultural well pumps could result in increased criteria pollutant emissions at other power facilities. However, the power facilities that would compensate for the additional power are already built and permitted to emit a maximum amount of criteria pollutants. These facilities are required to offset additional power generation by the use of pollution credit. Therefore, if additional emissions are generated, they would be generated by facilities that are permitted to do so. Impacts would be less than significant. • The various APCDs have determined some common types of facilities that have been known to produce odors in the region. These facilities include wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants. Construction and operation of new agricultural and municipal wells would not involve the type of facility identified by, for example, SJVAPCD, as a known odor source (SJVAPCD 2002). Consequently, it is expected new agricultural

Potential Environmental Effects of Substituting Surface Water with Groundwater	
Resource	Discussion
	and municipal wells would not create objectionable odors affecting a substantial number of people. Impacts would not occur. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction and operation of new agricultural and municipal groundwater wells would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction and operation of new agricultural and municipal groundwater wells would not result in growth because new groundwater wells would be constructed and operated to replace a water source that was reduced (e.g., surface water) rather than to increase capacity to serve new water supply users. The construction and operation of new agricultural and municipal groundwater wells would not result in population or employment growth that would result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Accordingly, this impact is less than significant.
Biological Resources	• It is expected that construction and operation of new agricultural groundwater wells would be in agricultural lands or adjacent to agricultural lands in the plan area and extended plan area. Agricultural lands generally have a low potential for special-status plant species, animal species, and habitat because they are actively managed, modified, and disturbed regularly for agricultural activities. Agricultural groundwater wells have a relatively small footprint (e.g., less than 1/4 of an acre) so the wells could be located to avoid special-status plant species, animal species, or habitat if needed. Therefore, there is a low potential for construction and operation of new agricultural groundwater wells to result in a conflict with local policies or ordinances protecting biological resources, or adopted habitat conservation plans or natural community conservation plans. Table 16-38 lists potential mitigation measures that lead agencies (e.g., irrigation districts) can and should implement in the unlikely circumstance that special-status biological resources and habitat are present within a proposed groundwater well site. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the relatively small footprint of disturbance and relatively short term duration of construction. • It is expected that construction and operation of new municipal groundwater wells in the plan area and extended plan area would be in urban and suburban areas close to existing municipal water supply systems (e.g., wells, distribution pipelines and infrastructure, and water supply treatment facilities). These areas are expected to have a low potential for special-status biological resources and habitat (including federally protected wetlands) to occur because these areas are typically developed with impervious surfaces that generally do not support the required habitat. However, any vegetated areas disturbed during construction would be revegetated, as necessary, to avoid

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	impacts on biological resources. Further, because municipal groundwater wells would have a relatively small footprint (e.g., between 1/4 and 1 acre), it is expected the wells could be located to avoid sensitive biological resources and habitats, if needed. Therefore, there is a low potential for construction and operation of new municipal groundwater wells to conflict with local policies or ordinances protecting biological resources, or adopted habitat conservation plans or natural community conservation plans. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipal water purveyors) can and should implement, in the unlikely circumstance special-status biological resources and habitat are present, to reduce potentially significant environmental effects on special-status biological resources and habitat. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the relatively small footprint of disturbance and the potential ability to avoid sensitive biological resources.
Cultural Resources	• Construction of agricultural and municipal groundwater wells would result in ground-disturbing activities. Ground-disturbing activities have the potential to affect significant unknown cultural resources (significant historical, archeological, or paleontological resources) if they exist at the groundwater well site. • Construction and operation of new agricultural groundwater wells in the plan area and extended plan area would likely be located in existing agricultural lands or adjacent to active agricultural lands. Active agricultural lands are regularly disturbed and are considered permanently disturbed after a period of time. Therefore, construction of agricultural groundwater wells would have a low potential to have existing unknown significant cultural resources. Operation of agricultural groundwater wells has a very low potential to affect cultural resources because the wells would only be pumping groundwater. Impacts would be less than significant. • Construction and operation of new municipal groundwater wells in the plan area and extended plan area would likely exist in urban and suburban areas adjacent or within close proximity to existing water supply infrastructure. While it is unknown if cultural resources exist, urban and suburban areas are likely previously disturbed, reducing the potential for significant unknown cultural resources to exist. Impacts would be less than significant. • Operation of municipal groundwater wells has a very low potential to affect cultural resources because the wells would only be pumping groundwater to the potable water distribution systems. Impacts would be less than significant. • As described above, it is expected the new groundwater well sites would be previously disturbed. The depth of sediment disturbance generally would be minimal (e.g., less than 5 ft), with the exception of the exact location of each well, which could disturb sediment up to the depth of the well (e.g., 35–400 ft). Therefore, it is highly unlikely that human remains, typically buried at depths of 6 ft, would be disturbed during construction. If human remains are uncovered during construction, compliance with the State Health and Safety Code would be required. As specified by Section 7050.5 of the Health and Safety Code, and described in Table 16-38, no further disturbance would occur until the county coroner has made the necessary findings as to origin and disposition pursuant to Public Resources Code Section 5097.98. If the coroner recognizes the remains to be Native American, he or she would contact the Native

Potential Environmental Effects of Substituting Surface Water with Groundwater	
Resource	Discussion
	American Heritage Commission (NAHC), which would appoint the Most Likely Descendent. Additionally, if the human remains are determined to be Native American, a plan would be developed regarding the treatment of human remains and associated burial objects, and the plan shall be implemented under the direction of the Most Likely Descendent. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because of the relatively small footprint of disturbance and the low potential for human remains to exist.
Geology and Soils	• It is assumed that placement of any new groundwater wells would be done such that the following would be avoided: areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. Any new facilities would be constructed using the latest geotechnical information for the site-specific conditions. Operation of agricultural or municipal groundwater wells would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. Further, changing the volume of groundwater pumped would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Construction of agricultural or municipal groundwater wells would result in limited ground-disturbing activities that could cause soil erosion or loss of topsoil; however, ground-disturbing activities would be limited in duration and geography. Ground-disturbing activities on 1 acre or greater would require preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP), as required by the Central Valley Regional Water Quality Control Board (Central Valley Water Board). The SWPPP would require soil and erosion control mechanisms. Table 16-38 includes potential mitigation measures that lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement to reduce potentially significant impacts on geologic resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the need to comply with existing storm water pollution and control regulations and the relatively small area of disturbance. • The construction and operation of new agricultural or municipal groundwater wells would not involve constructing or operating septic tanks and, therefore, septic tanks would not be affected by soils incapable of supporting the use of them or other alternative wastewater disposal systems. Impacts would not occur.
Greenhouse Gas Emissions	• Construction of new agricultural and municipal groundwater wells would result in increased GHG emissions because heavy equipment would be used. Similarly, operation of new agricultural and municipal groundwater wells would result in increased use of electricity and fossil fuels for pumping groundwater and for the routine transport of chemicals for those wells requiring a disinfection system (i.e., municipal wells), and, therefore, operations would result in an increase in GHG emissions. The potential increase in GHG emissions could be potentially offset by reductions in surface water diversions that often require the use of electric or fuel pumps to lift water into canals. MCAPCD has established a threshold of significance for carbon dioxide (CO_2) and methane (CH_4) at 500 tons per year. These thresholds of significance are for the operational phase only, as no construction-period thresholds have

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	been established. Although the *Tuolumne County Regional Blueprint Greenhouse Gas Study* (Tuolumne County 2012) identified a project-level greenhouse gas (GHG) emissions threshold of 4.6 metric ton carbon dioxide equivalent (MT CO_2e) per service population (the sum of the number of jobs and the number of residents provided by a project), the threshold is not applicable to the LSJR alternatives because they are not typical of a land use project with associated jobs and residents. Although the SJVAPCD has not established construction-related GHG thresholds, they have identified a level of GHG emissions per year (230 MT CO_2e) below which project-specific increases in GHG emissions would be considered equivalent to zero for CEQA purposes. This amount, known as a zero equivalency level (ZEL), can be used to evaluate construction emissions when they are amortized over a project's anticipated operational lifespan. A project using a 30-year operational lifespan would be considered significant if total construction emissions would exceed 6,900 MT CO_2e (230 MT CO_2e/year* 30 years = 6,900 MT CO_2e), while a project using a 50-year operational lifespan would be considered significant if total construction emissions would exceed 11,500 MT CO_2e (230 MT CO_2e/year * 50 years = 11,500 MT CO_2e). If wellhead treatment was required and depending on the type of treatment and what the water is being treated for, additional energy may be required beyond just pumping requirements. It is possible that substituting surface water with groundwater could result in a potentially significant GHG impact beyond the SJVAPCD ZEL, although the extent to which is unknown. For air districts in which there is no adopted GHG threshold (e.g., CCAPCD), the ZEL for SJVAPCD could be applied. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipal water purveyors) can and should implement to reduce potentially significant impacts related to construction and operation activities and GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted Assembly Bill 32, the California Global Warming Solutions Act of 2006 (AB 32). AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the California Air Resources Board (ARB) is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs • AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions

Potential Environmental Effects of Substituting Surface Water with Groundwater	
Resource	Discussion
	associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Construction activities associated with installing agricultural or municipal groundwater wells would be short term in nature and may involve limited transport, storage, use, and disposal of small quantities of hazardous materials such as fuel and lubricating grease for motorized heavy equipment. Some examples of typical hazardous materials handling are fueling and servicing construction equipment on the site, and transporting fuels, lubricating fluids, solvents, and bonding adhesives. These types of materials are not acutely hazardous, and storage, handling, and disposal of these materials are regulated by local, county, and state laws. Further, the quantities of these materials used during construction would be limited (e.g., less than 100 gallons) because of the short construction timeline. If a hazardous material spill occurred, it could be contained. Table 16-38 lists potential mitigation measures that lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement to reduce potentially significant impacts related to construction activities and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the relatively amount of materials to be used, handled or transported and the short duration of use over the course of construction. • The location of where new agricultural and municipal groundwater wells would be sited is not yet known; however, construction could be located within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. As such, if a school existed within close proximity to construction of new agricultural and municipal groundwater wells, those mitigation measures identified table 16-38 applied to project-specific construction needs would reduce potentially significant impacts during construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962. These sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the Department of Toxic Substances Control (DTSC) for Alpine, Calaveras, Tuolumne, or Mariposa Counties (CalEPA 2016). There were a total of 19 sites identified for Madera, Merced, San Joaquin, and Stanislaus Counties. In addition to these sites identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received cease and desist

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	orders (CDOs) or clean up abatement orders (CAOs), and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 520 leaking underground storage tanks designated as open in these counties (CalEPA 2016). There are approximately 60 facilities in these counties that have received CDOs/CAOs not identified as non-hazardous wastes, domestic wastewater, or domestic sewage (CalEPA 2016). The active and open leaking underground storage tank cases and the CDO/CAO facilities are located throughout these counties. Although it is not yet known where the new agricultural and municipal groundwater wells would be constructed, it is reasonable to assume that groundwater and soil would be tested prior to drilling, given the groundwater would ultimately be used. Thus if soil or groundwater contamination was present the well site would be relocated or modified (i.e., potential wellhead treatment). It is also reasonable to assume these Cortese List sites would not be selected as project sites given that drilling and excavation would be required for well installation and that groundwater could potentially be contaminated. However, if a new agricultural or municipal groundwater well were constructed and operated on a Cortese Site there would be potential for release of existing soil contaminants into soil or groundwater and surface water depending on the type of contaminant and its location, and to other proximal land areas due to ground disturbance during construction, and to water use during operation, of the wells. Were this to occur, impacts would be significant. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. Operation of new agricultural wells would likely not use hazardous materials because agricultural well water does not need to be treated or meet drinking water quality standards. Impacts would not occur. • Operation of new municipal groundwater wells could use a disinfection system, which could require the routine transport, use, storage, and disposal of hazardous materials, such as chlorine gas, sodium hypochlorite, or ammonia. Depending on the location of the new municipal groundwater wells, these materials could be used within 1/4 mile of a school because municipal groundwater wells would likely be within urban and suburban areas to serve existing water users. These materials are commonly used by water purveyors to disinfect groundwater prior to release in the distribution system and comply with safe drinking water standards. Chlorine gas is a non-flammable, non-explosive, and non-combustible gas. However, chlorine gas can form explosive compounds with other chemicals such as ammonia. Chlorine gas exposure can cause severe skin, eye, and lung tissue burns (ATSDR 2016). Sodium hypochlorite (solution of 12.5 percent) is a non-flammable, non-explosive, and non-combustible liquid that can cause skin and eye irritation or burns (HASA MSDS 2011). It is unlikely to be inhaled and is not typically anticipated to be ingested; however, vapor may cause irritation to the upper respiratory tract if inhaled (HASA MSDS 2011). It is not listed by the Occupational Safety and Health Administration (OSHA) as a carcinogen (HASA MSDS 2011). Ammonia (solution of 29 percent) is a non-combustible, non-explosive, and non-flammable liquid (MSDS 2011).

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	However, ammonia vapors are released if the chemical is heated (MSDS 2011). Primary potential routes of entry to humans are dermal (skin) contact and respiratory (breathing). Ammonia vapors are known to be a strong irritant to the eyes, skin, and respiratory tract (MSDS 2011). Generally, municipal wells that use these types of chemicals (i.e., sodium hypochlorite and ammonia) have double containment systems and are located in a spill containment area as required by local fire departments for the management and handling of these types of chemicals. Chlorine gas would be used and stored in accordance with applicable local, county, and state regulations and laws. Further, they would likely be in a locked building, and the water purveyors would be expected to conduct regularly scheduled inspection and maintenance of disinfection systems as they currently do on other municipal wells. Because of these precautionary design features, it is highly unlikely a spill of the sodium hypochlorite or ammonia would occur. However, in the unlikely event of a spill, the primary hazard to humans would be direct contact with skin and respiratory irritation as it currently is with the existing disinfection system. Operation of a new municipal groundwater well could also require onsite treatment and removal of water pollutants (e.g., arsenic), which could also require transportation and potentially disposal of hazardous waste. Disposal of any hazardous waste would be in accordance with applicable federal, state, and local laws and regulations at approved facilities. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipal water purveyors) can and should implement to reduce potentially significant impacts related to operational activities and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The U.S. Department of Transportation (USDOT), the Federal Highway Administration, and the Federal Railroad Administration are the three entities that regulate the transport of hazardous materials at the federal level. The Hazardous Materials Transportation Act governs the transportation of hazardous materials. The regulations under this act are promulgated by the USDOT and enforced by the U.S. Environmental Protection Agency (USEPA). Therefore, all hazardous material deliveries would be tracked, and vehicles would be required to use roadways approved for the transportation of hazardous materials. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipal water purveyors) can and should implement to reduce potentially significant impacts related to operational activities and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • As specified in California Code of Regulations, title 19, division 2, chapter 4.5 (California Accidental Release Prevention [CalARP] Program Detailed Analysis), all businesses that handle specific quantities of hazardous materials are required to prepare a California Accidental Release Prevention Program Risk Management Plan (CalARP RMP). The CalARP RMP is the state equivalent of the federal RMP. CalARP RMPs include the preparation of an offsite consequence analysis of worst-case release of the stored chemicals and the preparation of emergency response plans, including coordination with local emergency response agencies. CalARP RMPs are required to be updated at least every 5 years and when there are significant changes to the stored chemicals. Additionally, water

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Resource	Discussion
	purveyors using these types of chemicals for their disinfection systems would be subject to the Hazardous Materials Release Response Plans and Inventory Act (also known as the Business Plan Act), which requires an entity or business using hazardous materials to prepare a business plan describing the facility, inventory, emergency response plans, and training programs. These plans must be submitted to the local Certified Unified Program Agency (CUPA) (e.g., San Joaquin County, Stanislaus County, Merced County, or local fire departments). Water purveyors must also comply with the CalARP Program and prepare an RMP, if required. The RMP is a detailed analysis of the potential accident factors and mitigation measures that can be implemented to reduce accident potential. The RMP may include items such as safety information, hazard review, operating procedures, emergency response plan, training requirements, and compliance audits. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipal water purveyors) can and should implement to reduce potentially significant impacts related to operational activities and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • It is unlikely that a well for potable water purposes would be drilled on a hazardous materials site. Prior to drilling the well, the lead agency (e.g., municipal water purveyors) would need to conduct subsurface studies to determine the site suitability and test the soil and groundwater for contamination. Impacts would be less than significant. • Construction and operation of new agricultural or municipal groundwater wells would not be a hazard or cause safety concerns to public or public use airports or private airstrips due to the low profile of the wells. As such, construction and operation of new agricultural or municipal groundwater wells would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Construction and operation of new agricultural or municipal groundwater wells would not physically interfere with an adopted emergency response plan or emergency evacuation plan because they would not be located within roadways. Impacts would not occur. • Construction and operation of new agricultural or municipal groundwater wells would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur.
Hydrology and Water Quality	• Construction of agricultural or municipal groundwater wells could result in temporary changes to storm water drainage, the existing drainage pattern of the site, erosion, or runoff associated with typical construction activities, such as grading or preparation of land. Operation of new agricultural or municipal groundwater wells would likely not create or contribute runoff water that would increase the capacity of existing or planned storm water drainage systems, modify existing drainage patterns, increase erosion, or increase runoff because the wells would likely not result in substantial increases in impervious surfaces (e.g., concrete pads), which are typically associated with modification of drainages, erosion, and runoff. As discussed in the Geology and Soils section of this table, water purveyors would be required to prepare and implement a SWPPP for disturbed areas of over 1 acre. In addition, as discussed in this table for Hazards and Hazardous Materials, construction of new agricultural

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Resource	Discussion
	and municipal groundwater wells may involve the limited transport, storage, use, and disposal of hazardous materials, which, if spilled, could have adverse effects on water quality depending on the location and magnitude of the spill. However, storage, handling, and disposal of these materials is regulated by local, county, and state laws, and the quantities of these materials used during construction would be small (e.g., less than 100 gallons) and construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained and, as such, violations of water quality standards are not expected to occur. Table 16-38 lists potential mitigation measures that lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the relatively small area of disturbance and the short duration of construction. • The location of all new agricultural and municipal groundwater wells are as yet unknown. However, if the wells were located within a 100-year flood hazard area, the wells and any structure protecting the wells would have a low potential to impede or redirect flood flows given that these structures would be relatively low profile. Further, construction and operation of new agricultural and municipal wells would not affect housing and therefore would not place housing within a 100-year flood hazard area. Construction of agricultural and municipal wells would not result in flooding or otherwise cause flooding. Impacts would not occur. • New agricultural and municipal wells would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to flood hazard locations. As such, construction and operation of new wells would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Well construction is regulated by DWR (DWR 2012). The legislature authorized the establishment of well standards (DWR Bulletins 74–81 and 74–90) and regulations pertaining to the construction, alteration, and destruction of wells. Water Code Section 13750.5 requires that those responsible for the construction, alteration, or destruction of water wells, cathodic protection wells, groundwater monitoring wells, or geothermal heat exchange wells possess a C-57 Water Well Contractor's License. This license is issued by the Contractors State License Board. Water Code Section 13751 requires that anyone who constructs, alters, or destroys a water well, cathodic protection well, groundwater monitoring well, or geothermal heat exchange well must file with DWR a report of completion within 60 days of the completion of the work. Further, most counties and some cities have adopted ordinances to protect groundwater quality (e.g., where groundwater wells would likely be drilled in San Joaquin, Stanislaus, and Merced Counties). These ordinances require permits to be issued before a well can be drilled or modified. Thus, adequate well drilling procedures are established to avoid cross connections between aquifers. Avoiding aquifer cross connection ensures the wells and the aquifers are appropriately protected and do not result in groundwater contamination. Impacts would be less than significant.

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	• Construction new agricultural and municipal groundwater wells would not result in a substantial depletion of groundwater supply because construction activities would not use substantial amounts of water. Impacts would not occur. • Construction of a single well only requires the water used by the drilling equipment and the water to test the well and pump prior to operation (DWR 2012). Impacts would be less than significant. • The State Water Board's Division of Drinking Water (DDW) regulates drinking water supplies in the state of California, including municipal groundwater wells. Drinking water related statutes are from the Education Code, Food and Agricultural Code, Government Code, Health and Safety Code, Public Resources Code, and Water Code. Regulations are from Title 17 and Title 22 of the California Code of Regulations. The DDW permits all water purveyors in the state with water supply permits. Therefore, municipal wells are not expected to result in a reduction or change in water quality, and would not violate water quality standards. Impacts would be less than significant. • Groundwater wells are not typically located on the side of steep slopes. New agricultural or municipal groundwater wells would likely be located in flat areas. Therefore, the locations would not support mudflows, which typically need steep slopes and large amounts of precipitation to occur. Additionally, the wells would not be adjacent to the ocean and would not be affected by tsunamis. Impacts would be less than significant. • Increases in localized groundwater pumping could occur if municipal or agricultural providers pump groundwater instead of performing some other indirect action (e.g., developing recycled water sources or reducing demand). However, increases in localized groundwater pumping could result in similar impacts on groundwater and geologic resources to those broadly discussed by groundwater subbasin in Chapter 9, *Groundwater Resources*. Table 16-38 lists potential mitigation measures that lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Operation of new agricultural and municipal groundwater wells would not need the construction of additional storm water drains because the amount of impervious surfaces that could generate storm water runoff is anticipated to be very small. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction of new agricultural and municipal groundwater wells is not expected to occur in close proximity to a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of new agricultural or municipal groundwater wells could result in a substantial degradation of water quality.

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
Land Use and Planning	• Construction and operation of new agricultural or municipal groundwater wells would not physically divide an established community because wells and well fields are generally relatively small in scale (e.g., less than 1 acre) and would likely be located in existing available and open land (e.g., existing agricultural lands or land not being used for homes). Impacts would be less than significant. • Agricultural and municipal infrastructure, such as groundwater wells, are typically allowed in different land use designations (e.g., public facilities, residential, industrial) and different zoning designations. If the groundwater wells were inconsistent with applicable land use plans, policies, or regulations, an amendment or variant from the local jurisdiction approving the discretionary action associated with the groundwater wells would be required prior to approval and construction of the well. If no discretionary actions occur as a result of the construction or operation of new groundwater wells, then it is assumed those wells would not result in a conflict with local land use plans, policies, or regulations. Impacts would be less than significant. • Potential conflicts with applicable habitat conservation plans or natural community conservation plans, or other plans, policies and regulations protecting biological species and resources are evaluated in the Biological Resources section of this table.
Mineral Resources	• Construction and operation of new agricultural or municipal groundwater wells would have a very low potential to result in the removal or inability to access state or locally designated mineral resource areas in the plan area and extended plan area. This is because the groundwater well sites would be relatively small, and they are expected to be located either within or in close proximity to agricultural lands or within urban and suburban areas. If the groundwater wells are located within a state or locally designated mineral resource area, the drilling and operation of a groundwater well would not permanently remove access to a mineral resource as there would be other locations around the groundwater well that could provide access to the mineral resource.
Noise	• Construction of agricultural groundwater wells could generate temporary noise. There is low probability that sensitive receptors (e.g., residential homes, hospitals, schools) would be located within close proximity to experience the temporary noise generated by the drilling of a groundwater well because these wells would be constructed either within agricultural lands or immediately adjacent to the lands. Construction of these wells would not result in ground-borne vibrations because vibrations are typically associated with pile driving or heavy industrial processes, and construction of groundwater wells do not require these types of activities. Impacts would be less than significant. • Construction of municipal groundwater wells could generate temporary noise. It is likely new municipal wells would be drilled in areas with suitable land use designations and zoning for infrastructure (e.g., agriculture or public facilities). However, the location of any new well would be speculative and sensitive receptors to noise (e.g., residential homes, hospitals) maybe located within proximity. As such, construction activities could temporarily expose people to noise levels in excess of standards established the local general plan, noise ordinance, or applicable standards of other agencies. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipal water purveyors) can and should implement to reduce potentially significant impacts related to noise during construction. Until such time that these potential mitigation measures are implemented, the impacts would

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Resource	Discussion
	remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the location of potential sensitive receptors because of the relatively short duration of construction. • The operation of agricultural or municipal groundwater wells may generate temporary noise when the groundwater well is pumping. However, the wells do not pump continuously. It is anticipated there would be low probability that sensitive receptors (e.g., residential homes, hospitals, schools) would be located within close proximity to experience the temporary operating noise generated. Municipal groundwater wells are often enclosed in some type of small low-profile structure or enclosed by a fence that would reduce the temporary operating noise of the well. However, the location of any new agricultural or municipal well would be speculative and it may be located near receptors sensitive to noise (e.g., residential homes, hospitals, schools, parks). Table 16-38 lists potential mitigation measures that lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement to reduce potentially significant impacts related to noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented during operation depending on the potential location of possible sensitive receptors. • The construction and operation of new agricultural or municipal groundwater wells would not bring people within close proximity to an airport or expose people to airport noise. Impacts would not occur.
Population and Housing	• The construction and operation of new agricultural or municipal groundwater wells would not involve the construction of new homes or businesses, extension of roads, or other actions that may induce substantial property growth in an area. Construction and operation of new agricultural or municipal groundwater wells would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people to the plan area and extended plan area. Finally, new groundwater wells would be constructed and operated to replace a water source that was reduced (e.g., surface water) rather than increasing capacity to serve new water supply users. Impacts would be less than significant. • The construction and operation of new agricultural or municipal groundwater wells would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the wells would be located in relatively small, isolated areas. New groundwater wells are likely be located on existing vacant land (e.g., within or in close proximity to agricultural lands or within or adjacent to existing drinking water supply infrastructure). Impacts would be less than significant.

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Resource	Discussion
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, the construction and operation of new agricultural or municipal groundwater wells would not involve an increase in population or housing in the plan area and extended plan area. In addition, new agricultural or municipal groundwater well projects would not include proposals for new housing or increase demands for school services or facilities. Impacts would not occur.
Recreation	• Recreational facilities are not typically located in agricultural fields, and the construction and operation of an agricultural groundwater well would not result in impacts on recreational facilities. In addition, construction and operation of new agricultural wells would not lead to the construction or expansion of recreational facilities in the plan area and extended plan area, which might have an adverse physical effect on the environment. Impacts would not occur. • New municipal groundwater wells would likely be located within close proximity to existing municipal wells or existing municipal distribution systems so that potable water can be distributed. If recreational facilities were located within very close proximity to the construction location, construction of municipal wells may affect the recreational facilities (e.g., construction noise, dust). However, it is expected that construction would be limited in duration (e.g., less than 3 months) and space because municipal wells typically have small dimensions. Construction and operation of new municipal groundwater wells would not increase the use of existing parks or recreational facilities in the plan area and extended plan area, and would not result in the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Construction of new agricultural or municipal groundwater wells could result in additional trips associated with construction workers. Agricultural groundwater wells would likely be located within or adjacent to agricultural lands and generally these areas do not experience traffic congestion. New municipal groundwater wells may be located in urban and suburban areas within the plan area and extended plan area that could already experience some traffic congestion. However, the temporary increased traffic during construction would have a low potential of exceeding level of service standards on roadways because of the relatively few trips anticipated and the relatively short construction time. Table 16-38 lists potential mitigation measures that lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement to reduce potentially significant transportation and traffic impacts related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented during construction given the temporary nature of construction and the low potential for exceeding level of service standards. • Construction and operation of new agricultural or municipal groundwater wells would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.

Potential Environmental Effects of Substituting Surface Water with Groundwater

Resource	Discussion
	• Operation of new agricultural groundwater wells would not generate additional trips beyond those required to maintain and farm the active agricultural lands. Municipal groundwater wells may generate maintenance trips, but it is likely they would not be a substantial addition to the trips already being incurred by the road system by water purveyors who maintain existing wells. Impacts would be less than significant.
Utilities and Service Systems	• Construction and operation of new agricultural or municipal groundwater wells in the plan area and extended plan area would not affect the ability to meet the wastewater treatment requirements of the Central Valley Water Board because the wells would not involve the discharge of recycled water from a wastewater treatment plant (WWTP). Additionally, because a well does not generate wastewater, it would not affect the treatment capacity of an existing WWTP. Impacts would not occur. • Construction and operation of new agricultural or municipal groundwater wells could involve the construction of water treatment facilities in the form of wellhead treatment at municipal wells. Environmental effects associated with onsite treatment facilities are discussed in this table for all resources (i.e., Aesthetics through Transportation and Traffic). Table 16-38 lists potential mitigation measures that lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement to reduce potentially significant construction or operation impacts on all environmental resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Construction and operation of new agricultural or municipal groundwater wells would not need the construction of additional storm water drains because the amount of impervious surfaces that could generate storm water runoff is anticipated to be very small. Impacts would be less than significant. • Construction and operation of new agricultural or municipal groundwater wells would not need new entitlements for water supply. Impacts would not occur. • The construction and operation of new agricultural or municipal groundwater wells in the plan area and extended plan area is not expected to generate substantial volumes of solid waste and would be required comply with all state requirements regulating solid waste. Impacts would be less than significant.

16.2.3 Aquifer Storage and Recovery

Reductions in surface water diversions are expected as a result of approving an LSJR alternative and the program of implementation. A reasonably foreseeable method to augment a water supply system is to store water in an aquifer for later use. Aquifer storage and recovery is the process of storing surface water in a groundwater basin so it is available later for extraction and beneficial use. This process augments groundwater basins by allowing storage of any excess available surface water so it can be used later when it would otherwise be unavailable. Typical storage components are gravity recharge basins or injection wells that move water under pressure from the surface to an underground aquifer. Typical water extraction components are wells that pump groundwater from the aquifer and send the water to an existing treatment plant or directly into a distribution system for beneficial use. Aquifer storage and recovery may also be a source of water for underground storage and surface water diverted under a specific basis of right. The costs and potential environmental impacts associated with obtaining more water from aquifer storage and recovery are evaluated below.

Cost Evaluation

Table 16-8, *Groundwater Recharge Projects Funded by the California Department of Water Resources Integrated Regional Water Management Implementation Grant Program, Phase 1*, identifies recently funded groundwater recharge projects. These projects are from the IRWM. The costs identified in Table 16-8 include planning, design, permitting, land acquisition/rights of way, construction, and administrative costs in 2009 dollars for the Consolidated Irrigation District's South and Highland Basin Project (DWR n.d.).

Table 16-8. Groundwater Recharge Projects Funded by the California Department of Water Resources Integrated Regional Water Management Implementation Grant Program, Phase 1

Applicant	Project	Project Cost	Operations & Maintenance Budget ($/year)	Production (AF/y)	20-Year Amortized Cost ($/AF/y)
Joshua Basin Water District	Joshua Basin Water District Recharge Basin and Pipeline	$8,028,000	$75,000	2,000	$238
Consolidated Irrigation District	South and Highland Basin Project	$4,627,000	$164,500	2,500	$158

Sources: Mojave Water Agency 2010; DWR n.d.

AF/y = acre-feet per year.

Environmental Evaluation

Summary of Potential Action

A standard aquifer storage and recovery approach could utilize existing irrigation canals and existing agricultural fields (primarily during the off-irrigation season of October–March, when the canals and fields have capacity) to release an unspecified volume of water such that it would percolate through the unlined canals and soil in the fields to recharge the groundwater. It is expected there would be no construction associated with this type of aquifer storage approach because existing canals and agricultural fields are suitable for allowing water to percolate into the ground and existing groundwater wells would be suitable for extraction. Excess surface water would be used to recharge the aquifer in certain months or water year types. It is anticipated that this type of standard aquifer storage and recovery approach could be instituted by agreements between irrigation districts and their members who privately own agricultural land or irrigation districts, members who own agricultural land, and local governments, local water purveyors, or groundwater management districts. Depending on the water users, their agreements, the surface water that is diverted, a particular users' right to store water would influence their ability to do so.

Another aquifer storage and recovery approach also could be established using active groundwater recharge with storage components, such as wells that move water under pressure from the surface to an underground aquifer, and extraction components, such as wells that pump groundwater from the aquifer and send the water to an existing treatment plant or directly into a distribution system for beneficial use. Assuming active groundwater recharge is used, the activities and infrastructure associated with an aquifer storage and recovery program would be similar to the activities described in Section 16.2.2, *Substitution of Surface Water with Groundwater*. Although aquifer storage projects sometimes include infiltration basins specifically designed and constructed to facilitate rapid infiltration to underground storage, constructing infiltration basins would likely remove agricultural land from production. Therefore, this is not anticipated to occur and the environmental effects of constructing infiltration basins are not analyzed.

Summary of Potential Environmental Effects

Development of a more standard aquifer storage and recovery program would reduce changes in groundwater levels and new facilities required to recover the stored water are not anticipated. Potential environmental effects associated with the development of a standard aquifer storage and recovery approach in the plan area and extended plan area are described in Table 16-9, *Potential Environmental Effects of Aquifer Storage and Recovery*. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, at the end of this chapter, lists potential mitigation measures associated with the development of this action and is referenced in Table 16-9 below where appropriate.

Development of an active groundwater recharge approach would result in impacts similar to those identified in Section 16.2.2, *Substitution of Surface Water with Groundwater*, and Table 16-7, *Potential Environmental Effects of Substituting Surface Water with Groundwater*. This is because active groundwater recharge could require the construction and operation of groundwater wells and distribution pipeline, resulting in similar environmental effects as those described in Table 16-7 for the construction and operation of municipal groundwater wells. Impacts associated with developing wells to facilitate aquifer storage and recovery are identified in Table 16-7 and are not incorporated into Table 16-9, *Potential Environmental Effects of Aquifer Storage and Recovery*.

Table 16-9. Potential Environmental Effects of Aquifer Storage and Recovery

Potential Environmental Effects of Aquifer Storage and Recovery	
Resource	Discussion
Aesthetics	• Aquifer storage would not necessarily involve physical alteration of existing agricultural lands or canals in the plan area and extended plan area. Aquifer storage could change the volume of water in canals and on agricultural lands during the winter season. This would not represent a substantial degradation to the visual character or quality of agricultural lands because viewers are frequently subjected to change under active agricultural practices. Aquifer storage and recovery is not anticipated to involve lights or glare. Impacts would not occur.
Agriculture and Forestry Resources	• Aquifer storage would involve adding water to canals or flooding agricultural lands (potentially including Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) in the plan area in the winter months. There are limited agricultural resources in the extended plan area and no designated Prime Farmland, Unique Farmland, or Farmland of Statewide Importance. The agricultural lands are already used for agricultural purposes. Using agricultural lands for groundwater recharge during the winter would not modify its agricultural purpose during the irrigation season (generally April–September). Additionally, the groundwater recharge would support agricultural use because stored water could be pumped from the aquifer to irrigate agricultural fields. Impacts would be less than significant. • Aquifer storage would likely occur on agricultural lands and not on land zoned for forest land or timberland, because those lands wouldn't be particularly suited to support aquifer storage and recovery. Therefore, aquifer storage would not be expected to result in conflicts with existing zoning for, or cause rezoning of, forest land or timberland, or result in the loss of forest land or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Aquifer storage and recovery is not expected to affect air quality because aquifer storage would not include activities (e.g., construction activities) that generate air quality emissions. Changing the timing and/or volume of water in existing canals and agricultural fields would not have the potential to generate air quality emissions. While there may be some energy required as part of lift pumps and stations, the additional energy would not be beyond what is currently experienced when operating the canals. Impacts would be less than significant. • The various APCDs have determined some common types of facilities that have been known to produce odors in the region. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants. Construction and operation of an aquifer storage and recovery project would not involve the type of facility identified by, for example, SJVAPCD, as a known odor source (SJVAPCD 2002). Consequently, it is expected aquifer storage and recovery would not create objectionable odors affecting a substantial number of people. Impacts would not occur. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean aquifer storage and recovery would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions

Potential Environmental Effects of Aquifer Storage and Recovery

Resource	Discussion
	budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. Aquifer storage and recovery would not result in growth because it would be operated to replace a water source that was reduced (e.g., surface water) rather than to increase capacity to serve new water supply users. Aquifer storage and recovery would not result in population or employment growth that would result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Accordingly, this impact is less than significant.
Biological Resources	• Aquifer storage would likely occur during wet years when there is extra water and during the winter when fish spawning is generally not occurring. Therefore, aquifer storage is not anticipated to affect special-status fish species or their habitat or the migration of such species. Aquifer storage is not anticipated to conflict with local policies or ordinances in the plan area and extended plan area protecting special-status fish species, adopted habitat conservation plans, or natural community conservation plans. Impacts would be less than significant.
	• An aquifer storage and recovery project is expected to flood agricultural lands in the plan area and extended plan area that might not otherwise be flooded during certain times of year (e.g., nonagricultural seasons, such as winter). Additionally, it could use existing canals that have additional capacity during the irrigation season, typically April–September. Agricultural lands generally have a low potential for special-status plant species, animal species, and habitat (including federally protected wetlands) because they are actively managed and are modified and disturbed regularly by agricultural activities. Further, flooding agricultural fields during the nonagricultural seasons may provide habitat to bird species migrating during this time period. Therefore, aquifer storage is not anticipated to conflict with local policies or ordinances protecting biological resources or conflict with an adopted habitat conservation plan or natural community conservation plan. Impacts would be less than significant.
Cultural Resources	• Aquifer storage and recovery would require no construction or ground disturbance. Aquifer storage and recovery would use existing canals and fields to allow surface water to percolate into the ground and recharge existing groundwater basins. This recharge method is expected to change the volume of water in existing irrigation canals and fields. There is a low potential for cultural resources (significant historical, archeological, or paleontological resources) to exist in these locations due to excessive and regular disturbance of land in the agricultural fields and due to the primary use of the canals to convey irrigation water. Impacts would be less than significant. • Since aquifer storage and recovery would have no ground-disturbing activities, it would not result in disturbance of unknown or known human remains. Impacts would not occur.

Potential Environmental Effects of Aquifer Storage and Recovery	
Resource	Discussion
Geology and Soils	• Changing the volume of water in a canal or on agricultural land in the plan area and extended plan area would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, unstable geologic units, expansive soils, or landslides. Additionally, changing the volume of water in a canal or on agricultural land would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur. • To allow surface water to percolate into the aquifer, the additional water must be kept in the canals and agricultural fields. Surface water flows that could result in soil erosion would not be released into the canals or agricultural fields, and the water released would be of an appropriate volume and timing to allow for groundwater recharge. Therefore, water erosion and runoff is unlikely to occur. Impacts would not occur. • Aquifer storage and recovery would not involve constructing or operating septic tanks. Further, aquifer storage and recovery projects would be planned away from existing septic tanks so that they would not be affected by soils incapable of supporting their use or other alternative wastewater disposal systems. Impacts would not occur.
Greenhouse Gas Emissions	• It is not expected that aquifer storage and recovery would generate GHG emissions because it would not involve physical changes (i.e., construction) and is not expected to result in activities that would generate GHGs. While there may be some energy required as part of lift pumps and stations, the additional energy would not be beyond what is currently required when operating the canals. Impacts would be less than significant.
Hazards and Hazardous Materials	• Aquifer storage and recovery would not involve transporting, using, or disposing of hazardous materials nor would it emit hazardous emissions because water and changing the volume of water in different areas is not considered hazardous. In addition, aquifer storage would not result in the reasonably foreseeable upset or accident conditions associated with hazardous materials. Impacts would not occur. • Aquifer storage and recovery has no potential to affect public or public use airports or private airstrips, or airport safety because it would not result in building structures near airports. Accordingly, aquifer storage and recovery would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Because hazardous materials, substances or waste would not be handled for implementation of aquifer storage and recovery, there would be no related impact on schools within one-quarter mile of where aquifer storage and recovery would occur. Impacts would not occur. • An aquifer storage and recovery project is expected to flood agricultural lands in the plan area and extended plan area. As such, given the location these projects would not occur on a hazardous materials site list compiled under Government Code Section 65962 (i.e., Cortese Site List). Impacts would not occur. • Aquifer storage and recovery would not involve building structures, construction of housing or an increase in population Therefore, there would be no wildland fire threat to people or structures from aquifer storage and recovery implementation.

Potential Environmental Effects of Aquifer Storage and Recovery

Resource	Discussion
	• Canals and agricultural fields are located in areas that typically do not have emergency response plans or emergency evacuation plans. Therefore, aquifer storage and recovery would not impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan. Impacts would not occur.
Hydrology and Water Quality	• While aquifer storage could result in a change in drainage such that inundation of agricultural lands may occur more frequently, aquifer storage would likely not generate more runoff relative to existing conditions. Therefore this action would not result in the capacity of existing or planned storm water drainage systems being exceeded. Holding water for infiltration is designed such that agricultural lands hold the water so it can percolate into the groundwater basin. Water flow in canals and water volume in agricultural fields would be controlled to prevent runoff. Water quality standards would be maintained because any discharge would have to comply with the Central Valley Water Board's water quality requirements. Impacts would be less than significant. • Aquifer storage and recovery would not involve the construction or operation of new structures. Existing infrastructure would be used to release surface water during wet years into agricultural lands and canals. Surface water would be used to inundate agricultural lands otherwise unused and allowed to percolate without flooding other areas. Therefore, aquifer storage is not expected to result in flooding or result in a flood risk to people or structures. Impacts would be less than significant. • Aquifer storage and recover would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to flood hazard locations. As such, aquifer storage and recovery would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Because aquifer storage and recovery would not involve the construction or operation of new structures, flood flows would not be impeded or redirected even if this action were to take place within a 100-year flood hazard area. In addition, aquifer storage and recovery would not affect housing and therefore would not place housing within a 100-year flood hazard area. Impacts would not occur. • Aquifer storage is intended to augment the water supply, and would result in an increase in groundwater recharge, which would be beneficial. Aquifer storage and recovery is not expected to result in increased groundwater pumping beyond the volume of water stored as a result of recharge. Impacts would be less than significant. • Aquifer storage would be located in areas of flat relief because active agricultural lands and canals are typically not located on the side of steep slopes. The locations would not be expected to support mudflows, which typically need very steep slopes and large amounts of precipitation to occur. Also, these areas would not be adjacent to the ocean or affected by tsunamis. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Aquifer storage and recovery is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which aquifer storage and recovery could result in a substantial degradation of water quality.

Potential Environmental Effects of Aquifer Storage and Recovery

Resource	Discussion
Land Use and Planning	• Aquifer storage and recovery is not expected to physically divide an established community because the canals and agricultural lands already exist. It is anticipated that aquifer storage and recovery would support agricultural land use and zoning designations as it would not remove agricultural land from production. If aquifer storage and recovery was inconsistent with local land use plans, policies, or regulations, and required a discretionary action by a local government agency, it would require an amendment or variant from the local jurisdiction prior to operation. Impacts would be less than significant. • Potential conflicts with applicable habitat conservation plans and natural community conservation plans, or other plans, policies and regulations protecting biological species and resources are evaluated in the Biological Resources section of this table.
Mineral Resources	• Aquifer storage would not result in the removal or inability to access state or locally designated mineral resource areas because aquifer storage would be located within existing canals and agricultural use areas. If existing canals and agricultural uses are located in a mineral resource area, the periodic flooding of agricultural lands would not permanently remove access to a mineral resource as there would be other locations and times of year that could provide access to the mineral resource. Impacts would be less than significant.
Noise	• Aquifer storage would require releasing surface water into existing canals to flood agricultural lands during the winter. This activity would not generate temporary or permanent noise or ground-borne vibrations. This activity would not bring people within close proximity to an airport or expose people to airport noise. Impacts would not occur.
Population and Housing	• Aquifer storage and recovery would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property growth in an area. Further, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people to the plan area and extended plan area. Finally, it would be operated to replace a water source that was reduced (e.g., surface water) rather than increasing capacity to serve new water supply users. Impacts would not occur. • Aquifer storage and recovery would not displace substantial numbers of people or existing housing or necessitate construction of replacement housing elsewhere because the change in volume of water (and timing of water release) would occur in existing canals and agricultural lands and not where people currently reside. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As population increases, the need for additional or new public services and public service facilities generally increases. Aquifer storage and recovery would not involve an increase in population or housing in the plan area and extended plan area. In addition, aquifer storage and recovery would not include proposals for new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.

Potential Environmental Effects of Aquifer Storage and Recovery

Resource	Discussion
Recreation	• Recreational facilities are not typically located in agricultural fields. Aquifer storage under agricultural lands in the plan area and extended plan area would not result in impacts on recreational facilities. In addition, aquifer storage and recovery would not lead to the construction or expansion of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Aquifer storage and recovery would not require construction so the actions would not generate construction trips. Aquifer storage and recovery would also not require substantial number of operation and maintenance trips beyond those that may be currently conducted because existing canals and agricultural lands would be used. Impacts would be less than significant. • Aquifer storage and recovery would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Aquifer storage and recovery would not involve the need for utilities or service systems because it would not require the construction or operation of wastewater or water supply facilities. It would not result in the generation of solid waste and would not require a new water supply. Impacts would not occur.

16.2.4 Recycled Water Sources for Water Supply

Reductions in surface water diversions are expected as a result of approving an LSJR alternative and the respective program of implementation. To overcome potentially reduced water supplies, recycled water may be used by surface water users. Recycled water is wastewater treated to an acceptable water quality standard at a WWTP and then distributed for use. Typically, recycled water costs less than potable water because it does not need to be treated to the same water quality standards. For example, a farmer can purchase recycled water at a discount to irrigate alfalfa for a dairy instead of purchasing potable water or pumping groundwater. Thus less potable water would be used for irrigation and could be available for other beneficial uses (e.g., municipal uses). The costs and potential environmental impacts associated with obtaining water from recycled water sources are evaluated below.

Cost Evaluation

The complexity and cost of a recycled water project depends on many factors, such as the level of treatment at the WWTP, the desired water quality for the second beneficial use, the volume of recycled water needed, and the distance from where recycled water is treated to where recycled water is used. Some categories of recycled water projects are listed in detail below.

Landscape Irrigation

Recycled water could be used to offset potable water used to irrigate parks, commercial campus landscapes, ornamental ponds, golf courses, recreational sports fields, botanical gardens, and other spaces where humans will not have direct contact with recycled water. To construct a landscape irrigation project, a wastewater treatment agency would likely need to determine potential recycled water users, determine the required water quality to meet recycled water demand, determine the volume of recycled water needed, secure agreements with potential recycled water users, make improvements to increase treatment at the WWTP, and construct a recycled water distribution system (with pumps). Landscape irrigation recycled water projects typically cost between $400 and $2,100 per AF, including capital, operations, and maintenance (WRF 2011).

Agricultural Irrigation

Similar to landscape irrigation, recycled water could be used to offset potable water used to grow crops. Due to permitting requirements, most recycled water used for agricultural irrigation is for nonhuman consumptive crops (e.g., alfalfa grown for livestock). Recycled water used for human consumptive crops is required to be treated to a higher water quality than recycled water used on nonhuman consumptive crops. The process to construct an agricultural irrigation recycled water project is similar to a landscape irrigation recycled water project and typical costs assume similar project components.

Direct Potable Reuse

Recycled water could be used to replace potable water for domestic use. Technology is available to treat WWTP effluent to drinking water standards. Direct potable reuse is practiced in areas where water supply is extremely scarce, such as Singapore, Namibia, and remote communities in the American West (WRF 2011). Major concerns for direct potable reuse are: public perception, balancing water chemistry, engineered storage buffers, blending with other water sources, and multiple barriers to ensure public safety (WRF 2011). Direct potable reuse projects typically cost $700–$1,200/AF, including capital, operations, and maintenance (WRF 2011).

Process Water

Recycled water could be used by the commercial, institutional, or industrial (CII) sector as process water. Some processes, such as water used in cooling towers at power plants, could use recycled water to offset their need for potable water. Water quality is a concern for CII users because the recycled water is likely used in systems designed for use with potable water, or highly treated potable water. Use of water of less quality may damage CII process equipment, reducing the economic feasibility of using recycled water. Constructing a process water recycled water project is the same as explained above under *Landscape Irrigation*, but more treatment is likely needed at the WWTP. Process water recycling projects typically cost the same as direct potable reuse projects due to the need for higher water quality.

Environmental Evaluation

Summary of Potential Action

The location, timing of construction, and details of the modifications to existing WWTPs and respective distribution systems to support the development of recycled water sources, are unknown at this time. It is assumed these modifications may be carried out by the municipalities and wastewater treatment service providers in the plan area that would have their surface water sources reduced. Municipalities and wastewater treatment service providers include, but are not limited to: City of Merced, City of Manteca, City of Modesto, City of Tracy, Lake Don Pedro CSD, and City of Stockton. Whether the WWTPs are modified or not depends on a number of variables, such as market availability for recycled water use, future agreements reached between wastewater treatment service providers and potential end users water districts (if they are the end users), and funding availability.

For purposes of this discussion, it is assumed construction and operation would occur within the footprint of an existing WWTP or within very close proximity to one because wastewater recycling needs to be integrated into the existing wastewater treatment. It is also assumed WWTPs are located within close proximity to receiving waters (e.g., creeks or rivers) because WWTPs typically discharge treated effluent into receiving waters. Finally, it is assumed WWTPs are located in more urbanized areas adjacent to industrial and urban uses because (1) they must be located in an area to serve their existing municipal customers, and (2) they are typically considered public facilities that are generally located on lands designated and zoned for public facilities and industrial uses. The distribution system for recycled wastewater distribution would likely be constructed and operated within existing rights of way of roads and would be located below ground surface adjacent to existing utility lines at depths of 3–8 ft. The new lines would likely be in municipal service district areas and generally within urban areas.

Modifications required for existing WWTPs cannot be known at this time because they would depend on the type of wastewater treatment currently conducted at a WWTP, the availability of resources (e.g., funding and space), and the management of the WWTP by the local wastewater treatment special district or municipality. However, for the purposes of this discussion, it is assumed the operation of a modified WWTP to produce recycled water would be similar to the existing normal operation of a WWTP and would not result in a substantial increase in the volume of treated effluent discharged because the effluent would be distributed to recycled water users. Furthermore, it is anticipated that the operation of the recycled water facilities within the WWTP would be conducted by the existing employees at the WWTP.

Potential Environmental Effects

Construction of any recycled water facilities would likely result in temporary, and localized effects typically associated with similar activities including air quality effects and ground disturbance. Increased use of recycled water (e.g., landscape irrigation) may result in some runoff into local waterways; however, the quality of recycled water for such uses is highly regulated and approaches potable quality. In addition, increased use of recycled water will result in an equivalent decrease in discharge of lower quality treated effluent, thereby resulting in no negative impacts related to water quality of local waterways.

Recycled water treatment facilities are typically relatively energy intensive; however, the overall increased electrical demand would be small compared to the existing electrical demand of the service area. Therefore, it is unlikely to require the construction of major new power generation or transmission facilities. The operation of recycled water facilities may require a slight increase in chemical transport and storage, but as the treatment facilities would likely be constructed within or adjacent to existing WWTPs, the increase would be negligible compared to existing chemical use and transport at these locations.

It is likely that recycled water facilities would be constructed in areas that are already disturbed by urban development, and most facilities would be located within existing facility footprints and rights-of-way. In addition, any new recycled water projects would undergo CEQA review and other required regulatory compliance at the time they are proposed.

Table 16-10, *Potential Environmental Effects of Developing Recycled Water Sources*, summarizes the potential environmental effects associated with developing recycled water sources. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this action and is referenced in Table 16-10 where appropriate.

Table 16-10. Potential Environmental Effects of Developing Recycled Water Sources

Potential Environmental Effects of Developing Recycled Water Sources	
Resource	Discussion
Aesthetics	• Construction and operation of recycled water facilities would not be expected to significantly affect the visual character or quality of areas because they would be located within the existing footprint of WWTPs or within close proximity and would be similar in size and scale as the existing WWTP facilities. Construction of the recycled water distribution system would include installing pipeline generally along the rights-of-way of existing roads. Construction of the distribution system could result in temporary impacts on the visual character or quality of chosen sites and surroundings due to ground disturbance. Ground-disturbing construction activities would have the potential to disturb or remove mature vegetation (i.e., landscaping) and create dust clouds, which could affect views. Impacts would depend on the location of sensitive receptors relative to these construction sites. At this time, however, no specific projects have been proposed, and future distribution system alignments are unknown. Construction and operation of recycled water facilities may have operational and safety lights. Impacts would depend on the location of sensitive receptors to potential lighting. However, lights would be expected to follow lighting guidelines and lighting plans of local jurisdictions approving the construction and operation of the recycled water facilities. In addition, the recycled water facilities would likely be located adjacent to wastewater treatment facilities and infrastructure that may already have operational and safety lighting. Table 16-38 identifies potential mitigation measures lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant environmental effects associated with lighting and removal of mature landscaping vegetation. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the potential location of possible sensitive receptors and the ability to reduce light and glare.
Agriculture and Forestry Resources	• Recycled water treatment facilities would not be expected to be constructed on agricultural land (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) but rather within the footprint of an existing WWTP or within very close proximity to one. Construction of a recycled water distribution system would include installing pipeline generally along the rights-of-way of existing roads, and therefore it is unlikely that agricultural land would be affected. However, if any portions of distribution pipelines were installed on agricultural land, agricultural use of that land would be temporarily precluded during construction. Construction on agricultural land would be avoided to the extent feasible and could potentially occur outside of the agricultural production season, depending on the crop and location. Construction in agricultural fields may also require removal of crops, depending on the crop and time of year. Table 16-38, identifies potential mitigation measures lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant environmental effects on agricultural resources. At this time, no specific projects have been proposed, and the actual future distribution system alignments are unknown. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of potential disturbance of agricultural lands during construction. It is also expected that recycled water would

Potential Environmental Effects of Developing Recycled Water Sources

Resource	Discussion
	partially replace surface water diversions for agricultural irrigation, which could potentially offset impacts on agricultural land affected by the recycled water facilities. • Limited forestry resources occur in the plan area. Although extensive forestry resources occur in the extended plan area (e.g., Stanislaus National Forest), because recycled water treatment facilities would be expected to be sited within the footprint of an existing WWTP or within close proximity to one, construction and operation of the facilities would likely not conflict with existing zoning for, or cause rezoning of, forest land or timberland, or result in the loss of those zoned lands. Impacts would be less than significant.
Air Quality	• The plan area is located in the SJVAB and partially located in the MCAB. The extended plan area is also partially located in the SJVAB, MCAB and the GBVAB. The recycled water sources could be located in any or all of these air basins, which generally cover San Joaquin, Stanislaus, Merced, Mariposa, Tuolumne, Calaveras, Alpine, and Madera Counties, because the water supplied by the wells could support agricultural or municipal uses in these areas. The plan area and extended plan area occur within the jurisdictions of the SJVAPCD, CCAPCD, the GBUAPCD, MCAPCD, and TCAPCD. Recycled water facilities would likely be located in the SJVAB, which generally covers San Joaquin, Stanislaus, Merced, and Madera Counties. SJVAPCD's published guidelines, *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002) do not require the quantification of construction emissions. Rather, the guidelines require implementation of effective, comprehensive, and feasible control measures to reduce PM10 emissions (SJVAPCD 2002). SJVAPCD considers PM10 emissions to be the greatest pollutant of concern when assessing construction-related air quality impacts and has determined that compliance with its Regulation VIII, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), constitutes sufficient mitigation to reduce construction-related PM10 emissions to less-than-significant levels and minimize adverse air quality effects. All construction projects must abide by Regulation VIII. Since the publication of the district's guidance manual, the district has revised some of the rules comprising Regulation VIII. Guidance from district staff indicates that implementation of a Dust Control Plan would satisfy all of the requirements of SJVAPCD Regulation VIII (Siong pers. comm.). Further consultation with SJVAPCD staff indicates that, though explicit thresholds for construction-related emissions of ozone precursors are not enumerated in the *Guide for Assessing and Mitigating Air Quality Impacts*, SJVAPCD considers it a significant impact when construction or operational emissions of ROG or NO_X exceed 10 tons per year or if PM10 or PM2.5 emissions exceed 15 tons per year (Siong pers. comm.). For projects within CCAPCD jurisdiction a significant impact would occur if project emissions are greater than 150 pounds per day for ROG, NO_X, or PM10 in either the construction or operational periods. No thresholds for other criteria pollutants or their precursors have been established by the CCAPCD. The GBUAPCD does not have adopted quantitative thresholds of significance for criteria pollutants for proposed projects for the purposes of CEQA, although thresholds from neighboring air districts (e.g., CCAPCD, TCAPCD, SJVAPCD) may be used to evaluate impacts within the GBUAPCD. For construction impacts, the GBUAPCD requires that project proponents adopt comprehensive mitigation measures to mitigate fugitive dust impacts. For emissions associated with the operation of stationary sources, the GBUAPCD considers stationary emissions to be less than significant if they are exempt from Rule 202 pursuant to Rule 209-A(B)(2). Rule 209-A identifies emission limits of 250 pounds per day for ROG, NO_X, SO_X, and particulate matter. For projects within MCAPCD jurisdiction a significant impact would occur if project operational emissions are greater than 100 tons per year for ROG, NO_X, CO, SO_X,

Potential Environmental Effects of Developing Recycled Water Sources

Resource	Discussion
	PM10, and PM2.5 (County of Mariposa 2006). For projects within TCAPCD jurisdiction a significant impact would occur if project emissions are greater than 100 tons per year or 1,000 pounds per day for ROG, NO_X, CO, and PM10. • Construction of recycled water treatment facilities and distribution pipelines would likely result in emissions associated with construction equipment and construction worker vehicle trips, as well as fugitive dust emissions from ground disturbance. The quantity, duration, and the intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Depending on the level of activities and amount of infrastructure built, construction of recycled water facilities could exceed air quality thresholds established by the applicable APCDs and project proponents would be required to implement measures to help reduce or minimize construction-related emissions. Lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on air quality associated with construction emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the regulatory requirement to implement all required feasible measures to reduce emissions during construction and the potential for the duration and frequency of activities during construction to reduce overall emissions (e.g., diluting emissions over time). • Prior to constructing a project dealing with a stationary source of emissions (such as a WWTP), project proponents must obtain permits from their respective air districts to ensure the permitted facility will not cause a new violation, or contribute to an existing violation, of national ambient air quality standard. For example, an Authority to Construct (ATC) would be required from SJVAPCD if a facility were constructed within the SJVAB. The project would be subject to the requirements of SJVAPD Rule 2201. As stated under Sections 1.1 and 1.2 of Rule 2201[12]: *The purpose of this rule is to provide for the following:* *1.1 The review of new and modified Stationary Sources of air pollution and to provide mechanisms including emission trade-offs by which Authorities to Construct such sources may be granted, without interfering with the attainment or maintenance of Ambient Air Quality Standards;*

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[12] Sources whose primary function is permitted by the SJVAPCD through Rules 2010 and 2201 are not subject to SJVAPCD Rule 9510 (Indirect Source Review). Projects subject to Rule 9510 are required to quantify and reduce indirect (i.e., mobile source emissions), area-source (e.g., space heating, landscaping, and maintenance), and construction exhaust emissions.

Potential Environmental Effects of Developing Recycled Water Sources

Resource	Discussion
	1.2 No net increase in emissions above specified thresholds from new and modified Stationary Sources of all nonattainment pollutants and their precursors. Rule 2201 applies to new stationary sources and all modifications to existing stationary sources that are subject to permit requirements and after construction may emit one or more affected pollutant.[13] The requirements of this rule go in effect on the date the application is determined to be complete by the SJVAPD's Air Pollution Control Officer. • Operation of recycled water treatment facilities would likely use electricity because of their expected locations in urban and suburban areas in close proximity to existing wastewater treatment infrastructure. They may use nonelectric backup generators for intermittent emergency circumstances. Operations could include facility inspection and maintenance activities. The need for additional energy could result in increased criteria pollutant emissions at power generation facilities. However, the power facilities that would compensate for the additional demand are already built and permitted by the applicable local air district to emit a maximum amount of criteria pollutants. As part of the permitting process, these facilities are required to offset additional power generation by the use of emission reduction credits as required by applicable local air district New Source Review programs. Therefore, if additional emissions are generated, they would be generated by regulated facilities. Lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects associated with operational emissions and air quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The various APCDs have identified common types of facilities that are known to produce odors in the region. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants. Construction and operation of recycled water facilities would not involve the type of facility identified by, for example, SJVAPCD, as a known odor source (SJVAPCD 2002). The recycled water facilities would be located at the wastewater treatment facility but would not produce additional odors beyond what currently may be produced. This is because the recycled water process typically uses the existing volume of wastewater that is already treated in accordance with Clean Water Act permit requirements. The recycled water process further treats the wastewater to meet recycled water quality standards. Therefore, the additional processing of the treated wastewater does not produce any additional odors because the odors are typically generated

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[13] Affected pollutants are those pollutants for which an Ambient Air Quality Standard has been established by the USEPA or by the ARB, and the precursors to such pollutants and those pollutants regulated by the USEPA under the federal Clean Air Act or by the ARB under the Health and Safety Code including, but not limited to, VOC, NOx, SOx, PM2.5, PM10, CO, and those pollutants which the USEPA, after due process, or the ARB or the Air Pollution Control Officer, after public hearing, determine may have a significant adverse effect on the environment, the public health, or the public welfare.

Potential Environmental Effects of Developing Recycled Water Sources	
Resource	Discussion
	during pre-treatment, primary treatment, and biosolids removal. Consequently, it is expected that recycled water facilities would not create objectionable odors affecting a substantial number of people. Impacts would be less than significant. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction and operation of recycled water treatment facilities would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. Construction and operation of recycled water treatment facilities would not result in growth because the facilities would be constructed and operated to replace a water source that was reduced (i.e., surface water) rather than to increase capacity to serve new users. Construction and operation of recycled water treatment facilities would not result in population or employment growth that would result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Accordingly, this impact is less than significant.
Biological Resources	• Construction and operation of recycled water treatment facilities in the plan area and extended plan area is expected to be in urban and suburban areas within the footprint of existing WWTPs. These areas are expected to have a very low potential for special-status plant species, animal species, and habitat (including federally protected wetlands), and are unlikely to support special-status biological resources because they are typically industrial facilities with buildings and primarily impervious surfaces. Construction of the recycled water distribution system would include installing pipeline generally along the rights-of-way of existing roads, and potentially in agricultural fields and other areas (e.g., parks, commercial campus landscapes, golf courses). With the exception of agricultural fields, these other areas are expected to have a very low potential for special-status plant species, animal species, and habitat, because they are typically located in developed, urban areas. Some agricultural fields can provide suitable foraging habitat for special-status raptor species such as Swainson's hawk and white-tailed kite; however, given the temporary nature of construction activities associated with installing recycled water distribution pipelines and that activities typically could be scheduled to avoid active periods of these types of species, there is a low potential for effects. Further, there is also a low potential for special-status plant species, animal species, and habitat to be affected, it is not expected that construction and operation would conflict with local policies protecting biological resources or conflict with provisions of an adopted habitat conservation plan or natural community conservation plan. Depending on the actual location and the season of construction, Table 16-38 lists potential mitigation measures lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant environmental effects of construction and operations on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that construction

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	impacts could be mitigated to less than significant once mitigation measures were implemented, given the need to comply with regulatory seasonal restrictions. • It is expected that operation of recycled water facilities would not result in an increased volume of treated wastewater effluent discharged or change the quality of the treated wastewater effluent discharged, because it would be distributed to the end user for use on landscaping, potable use, or agricultural fields. As such, it is not expected to adversely affect special-status fish species. It is expected that recycled water production would meet all appropriate treated wastewater effluent limitations and standards and would not affect special-status fish species or the migration of such species. Impacts would be less than significant. • Use of recycled water by consumers (e.g., golf courses or industrial processes) could result in runoff entering receiving water and potentially affecting aquatic resources. However, consumers are required to have management plans to control runoff and reduce receiving water inflow. Specifically the applicable regional water quality control board is required by California Code of Regulations, title 22, division 4, to issue a Master Water Recycling Permit that includes specific requirements for the use of recycled water (SDRWQCB 2009). Further, the quality of recycled water for such uses is highly regulated by the regional water quality control boards and the California Department of Public Health by regulations or laws such as the Health and Safety Code (Division 104, Part 12, Chapter 4, Article 7, § 116551) and approaches potable water quality (CDPH 2011). Impacts would be less than significant.
Cultural Resources	• Construction and operation of recycled water treatment facilities would likely occur in urban and suburban areas adjacent or within close proximity to existing wastewater treatment facilities and infrastructure. While it is unknown if cultural resources (significant historical, archeological, or paleontological resources) exist in these locations, these areas likely would have been previously disturbed during the construction of the existing wastewater treatment facilities, reducing the potential for significant unknown cultural resources to exist. Operation of recycled water facilities would have a very low potential to affect cultural resources because operation would consist of recycled water treatment within previously constructed facilities. Impacts would be less than significant. • Construction and operation of the recycled water distribution system would include installing pipeline generally along the rights-of-way of existing roads. Construction of the distribution system has the potential to encounter significant unknown buried cultural resources because it cannot be predicted with certainty whether significant unknown buried cultural remains are currently present or absent. No specific projects have been proposed at this time, and the actual future distribution system alignments are unknown. However, given that most of the construction would occur within highly developed public rights-of-way where much of the sediments have been previously disturbed, the potential to encounter significant buried cultural resources is greatly reduced. In addition, due to the shallow depth of disturbance cultural resources have likely been previously disturbed. Therefore, there is a very low potential for unknown cultural resources to be located in these areas. Lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on cultural resources associated with construction of recycled water treatment and distribution facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable,

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	consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the depth of disturbance and the low potential for resources to exist. • As described above, it is expected the wastewater treatment sites and public-rights-of ways would be previously disturbed. Therefore, it is highly unlikely that human remains, typically buried at depths of 6 ft, would be encountered or disturbed during construction. However, if human remains are uncovered during construction, compliance with the State Health and Safety Code would be required. As specified by Section 7050.5 of the Health and Safety Code, and described in Table 16-38, no further disturbance would occur until the county coroner has made the necessary findings as to origin and disposition pursuant to Public Resources Code Section 5097.98. If such a discovery occurs, excavation or construction would halt in the area of the discovery, the area would be protected, and consultation and treatment would occur as prescribed by law. If the coroner recognizes the remains to be Native American, he or she would contact the NAHC, who shall appoint the Most Likely Descendent. Additionally, if the human remains are determined to be Native American, a plan would be developed regarding the treatment of human remains and associated burial objects, and the plan shall be implemented under the direction of the Most Likely Descendent. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.
Geology and Soils	• The locations of any new recycled water facilities could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, recycled water facilities would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. Any new facilities would be constructed using the latest geotechnical information for the site-specific conditions. Finally, recycled water facilities would not bring people to the risk of earthquakes or geologic hazards, meaning the operation of the recycled water facilities would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts related to geology and soils associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the temporary disturbance of soils during construction and the need to follow existing building code requirements. • The construction and operation of recycled water facilities would not involve constructing or operating septic tanks. Therefore, septic tanks would not be affected by soils incapable of supporting the use of them or other alternative wastewater disposal systems. Impacts would not occur.

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	• Construction of recycled water treatment facilities and distribution systems would result in limited ground-disturbing activities that could cause soil erosion or loss of topsoil; however, ground-disturbing activities would be limited in duration and geography. Furthermore, ground-disturbing activities of 1 acre or greater would require preparation and implementation of a SWPPP, as required by the Central Valley Water Board. The SWPPP would require soil and erosion control mechanisms. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts related to soil erosion and storm water runoff and erosion associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given that construction would be temporary and the need to comply with existing storm water pollution and control regulations. • Increases in groundwater pumping are not expected to occur under the construction of recycled water treatment facilities or the distribution system. Operation of recycled water facilities may result in replenishment of groundwater resources or a reduction of the groundwater pumping because the recycled water would be used as an alternative source of water. Impacts would be less than significant.
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-7, because construction and operation of recycled water treatment facilities and distribution systems would result in increased use of electricity and fuels, and therefore there would be an increase in GHG emissions. Depending on the level of construction activities, construction-related GHG emissions could exceed the SJVAPCD ZEL and result in a potentially significant impact. For air districts in which there is no adopted GHG threshold (e.g., CCAPCD), the ZEL for SJVAPCD could be applied. The recycled water treatment and distribution process is an energy-intensive process (e.g., brackish water reverse osmosis energy use will vary depending upon the salinity and temperature of the source water; the higher the salinity or the colder the water temperature, the more energy it takes to remove the salt to meet water quality standards [Kennedy/Jenks Consultants 2013]). However, the overall increased electrical load due to operation of a recycled water treatment facility would be extremely small compared to the existing local electrical demand and it is unlikely to require the construction of new major power generation or transmission facilities. However, these increased electricity-related GHG emissions could potentially exceed the applicable SJVAPCD ZEL threshold and result in a significant impact. For air districts in which there is no adopted GHG threshold (e.g., CCAPCD), the ZEL for SJVAPCD could be applied. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts due to GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs.

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	○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Construction of recycled water treatment facilities and the distribution systems would be short term and may involve the transport, storage, use, and disposal of hazardous materials such as fuel and lubricating grease for motorized heavy equipment. Some examples of typical hazardous materials handling are fueling and servicing construction equipment onsite and transporting fuels, lubricating fluids, solvents, and bonding adhesives. These types of materials are not acutely hazardous, and storage, handling, and disposal of these materials are regulated by local, county, and state laws. Furthermore, due to the limited construction period, the quantities of these materials used during construction is also anticipated to be small (e.g., less than 100 gallons). If a spill occurred, it could be readily and easily contained. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary. • The location of where recycled water treatment facilities and distribution systems would be constructed is not yet known; however, these facilities could be constructed within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation activities. As such, if a school existed within close proximity to construction of recycled water treatment facilities and distribution systems, those mitigation measures identified table 16-38 applied to project-specific construction needs would reduce potentially significant impacts during construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g.,

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	municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction.
	• Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962, these sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the DTSC for Alpine, Calaveras, Tuolumne, or Mariposa Counties (CalEPA 2016). There were a total of 19 sites identified for Madera, Merced, San Joaquin, and Stanislaus Counties. None of these sites are identified as a WWTPs. In addition to these sites identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 520 leaking underground storage tanks designated as open in these counties (CalEPA 2016). There are approximately 60 facilities in these counties that have received CDOs/CAOs not identified as non-hazardous wastes, domestic wastewater, or domestic sewage (CalEPA 2016). There are approximately 13 facilities identified as WWTPs in these counties as having non-hazardous active CDOs/CAOs (CalEPA 2016). The active and open leaking underground storage tank cases and the CDO/CAO facilities are located throughout these counties and although some of them are identified as non-hazardous, they are identified on a Cortese List. Construction and operation of recycled water treatment facilities would likely occur in urban and suburban areas adjacent or within close proximity to existing wastewater treatment facilities and infrastructure. It is not yet known precisely where recycled water treatment facilities would be constructed, and which WWTPs may choose to construct recycled water treatment facilities. If a recycled water treatment facility were constructed on a Cortese Site because construction of these facilities would likely entail some ground disturbing activities, there would be potential for release of existing soil or groundwater contaminants depending on the known or unknown existing or historical contamination at the site. Were this to occur, impacts could be significant. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed.
	• Construction and operation of recycled water treatment facilities would likely occur within close proximity to existing wastewater treatment facilities and infrastructure and therefore would not physically interfere with an adopted emergency response plans or emergency evacuation plans because construction and operation activities would not prohibit the mobility of people to escape potential emergencies. Standard practices and protocols with respect to emergencies that are currently implemented by wastewater treatment facilities would apply and recycled water treatment

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	facilities would be incorporated into the standard practices and protocols. Furthermore, construction and operation of these facilities would not involve an increase in population that would necessitate reconsideration of how to evacuate people in an emergency. Impacts would not occur. • Operation of recycled water treatment facilities could use chemicals during the wastewater treatment process, which could require the routine transport, use, storage, and disposal of hazardous materials, such as chlorine gas, sulfur dioxide, and aqueous ammonia. These materials are commonly used by WWTPs during their treatment process to comply with effluent discharge standards set by the Central Valley Water Board. These chemicals are considered corrosive and represent inhalation, ingestion, and contact hazards. WWTPs are required to have hazardous materials inventory (HMI) statements and a consolidated contingency plan, as well as a federal RMP and a CalARP RMP, to properly manage and control these hazardous materials per federal RMP regulations (40 CFR Part 68) and the federal OSHA's Process Safety Management regulations (29 CFR Part 1910.119). The RMPs include the preparation of an offsite consequence analysis of worst-case release of the stored chemicals, and preparation of emergency response plans, including coordination with local emergency response agencies. The RMPs are required to be updated at least every 5 years and when there are significant changes to the quantities of stored chemicals. In addition, the Hazardous Materials Release Response Plans and Inventory Act (also known as the Business Plan Act) requires a business using hazardous materials to prepare a Business Plan describing the facility, inventory, emergency response plans, and training programs. The local CUPA (e.g., San Joaquin County, Stanislaus County, or Merced County, or local fire departments) and USEPA have authority over the management of hazardous materials at WWTPs. WWTPs would likely be within urban and suburban service areas, potentially storing these hazardous materials within 1/4 mile of a school. Per existing regulations, the CalARP RMP would be updated accordingly to reflect the additional volume of chemicals that might be transported, used, or disposed of as a result of including recycled water facilities. Added transport, use, or disposal of chemicals would also require implementation of a revised CalARP RMP. As part of revising the CalARP RMP, the wastewater treatment facilities would evaluate if current containment systems would be adequate for the additional truck deliveries and make any necessary modifications. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during operation. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the need to comply with state and federal regulations in order to operate the recycled water facility. • Recycled water is not considered a hazardous waste (e.g., material that is corrosive, flammable, reactive). There are many regulations controlling the release, use, and management of recycled water to protect public health and the environment. For example, purple pipe systems are required for new recycled water distribution systems so that the systems are appropriately connected to the end use (e.g., landscaping), and minimize potential cross connection with potable water systems. Therefore, people would not be exposed to hazards or hazardous materials as a result of the use of recycled water. Impacts would be less than significant.

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	• Construction and operation of recycled water treatment facilities and the distribution system would not be a hazard or cause safety concerns to public or public use airports or private airstrips because recycled water facilities would be constructed and operated within the existing footprint of wastewater treatment facilities or within close proximity and distribution systems would be underground. As such, construction and operation of recycled water treatment facilities and the distribution system would not result in a safety hazard for people residing or working in or near the project area. Impacts would be less than significant. • Construction and operation of recycled water treatment facilities and distribution systems would not physically interfere with an adopted emergency response plan or emergency evacuation plan since they would be located within existing facilities and the existing rights-of-way of roads. During construction of the distribution systems, road shoulders or lanes may be closed, but typical traffic control methods would be employed to direct and control traffic and minimize traffic impacts. Impacts would be less than significant. • Construction and operation of recycled water treatment facilities and distribution systems would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur.
Hydrology and Water Quality	• Construction of recycled water treatment facilities and distribution systems could result in temporary changes to existing drainage patterns, erosion, or runoff associated with typical construction activities, such as grading or preparation of land. As discussed earlier in this table (Geology and Soils), soil disturbance of over 1 acre would require wastewater treatment special districts or municipalities to prepare and implement a SWPPP. Water quality measures such as monitoring turbidity during construction to ensure compliance with the applicable water quality objectives (e.g., Water Quality Control Plan for the Sacramento River and SJR Basins) and construction BMPs would be implemented as either mitigation measures under CEQA or permit requirements and conditions to ensure water quality standards are not exceeded. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary. • Because construction and operation of recycled water facilities would not substantially alter the existing drainage pattern of the site, or substantially increase the rate or amount of surface runoff, new recycled water facilities would not result in flooding or otherwise cause flooding on- or off-site, or exceed the capacity of existing or planned storm water drainage systems. Impacts would be less than significant. • It is likely that the recycled water facilities would be located in a flood hazard area because wastewater treatment facilities are typically located adjacent to rivers and streams so they can discharge treated effluent into receiving waters. However, because the recycled waste facilities would be located within the existing WWTP footprint, the addition of the recycled water facilities would not substantially add to the existing structures such that flood flows in a 100-year flood hazard area

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	would be impeded or redirected. Further, the recycled water facilities would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to flood hazard locations or place housing within a 100-year flood hazard area. As such, construction and operation of recycled water facilities would not expose people to significant loss, injury, or death related to flooding. Impacts would be less than significant. • Operation of recycled water treatment facilities would have to comply with all regulations pertaining to water quality standards and regulations to prevent degradation of water quality in receiving waters. It is not anticipated that the recycled water facility would discharge recycled water into receiving waters because the water would be distributed to users in the service area. The users of recycled water (e.g., golf courses) would have to prepare plans and undergo inspections by the municipality operating the WWTP and prepare management plans to limit and control runoff into receiving waters. Impacts would be less than significant. • Construction of recycled water treatment facilities and distribution systems would not result in a substantial depletion of groundwater or interfere with groundwater recharge because construction would generally take place within existing facility footprints and would not need substantial volumes of water. Operation of recycled water facilities could increase actual groundwater recharge if it is used to augment groundwater basins. Users of recycled water (e.g., golf courses) may reduce their use of groundwater because they would have an alternative source of water by using the recycled water. Impacts would be less than significant. • Construction and operation of recycled water treatment facilities and the distribution systems would be located in areas of flat relief because these types of facilities are typically not located on the side of steep slopes. The locations would not support mudflows, which typically need very steep slopes and large amounts of precipitation to occur. Further, these areas would not be adjacent to the ocean and would not be affected by tsunamis. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction recycled water treatment facilities is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of recycled water treatment facilities could result in a substantial degradation of water quality.
Land Use and Planning	• Construction and operation of recycled water facilities would not physically divide an established community because the facilities would likely be located in the existing footprint of the wastewater facility. Construction of the recycled water distribution system would include installing pipeline generally along the rights-of-way of existing roads, and potentially in agricultural fields and other areas (e.g., parks, commercial campus landscapes, golf courses). Construction activities would be temporary and pipelines would be below grade and therefore would not create an obstruction or barrier that would divide an established community. Impacts would be less than significant. • Construction and operation of recycled water facilities would take place within the footprint of an existing WWTP or within close proximity and would not conflict with land use designations or zoning because WWTPs are typically located in areas that are for public facilities or industrial uses. If the recycled water facilities or distribution systems were

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	inconsistent with applicable land use plans, policies, and regulations, an amendment or variant from the local jurisdiction approving the discretionary action associated with the recycled water facilities would be required by the project proponent prior to project approval and construction. If no discretionary action were to occur as a result of the construction or operation of the recycled water facilities or distribution systems, it is assumed it would not result in a conflict with local land use plans, policies, and regulations. Impacts would be less than significant. • Potential conflicts with applicable habitat conservation plans and natural community conservation plans are evaluated in the Biological Resources section of this table.
Mineral Resources	• Construction and operation of recycled water facilities would have a very low potential to result in the removal or inability to access state or locally designated mineral resource areas. This is because recycled water facility sites would be within the footprint of existing WWTPs. If the recycled water facilities or distribution systems are located within a state or local designated mineral resource area, construction and operation of the recycled water facilities would not permanently remove access to a mineral resource as there would be other locations around the facilities that could provide access to the mineral resource. Impacts would be less than significant.
Noise	• Construction of recycled water facilities could temporarily generate noise or ground-borne vibrations if pile driving is used. It is likely that recycled water facilities would be constructed in areas with suitable land use designations and zoning for infrastructure (e.g., public facilities or industrial) or within the footprint of existing facilities. It would be unlikely to have sensitive receptors (e.g., residential homes, hospitals, schools) to noise within close proximity to construction activities. If sensitive receptors were adjacent to construction activities and experienced construction noise, construction would be temporary and would be required to follow existing local noise ordinances limiting the timing of construction (e.g., generally Mondays– Fridays, 7am–6pm). Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts related to noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the location of potential sensitive receptors and the duration of the particular noise generating activities. • Wastewater treatment facilities do not generally run continuously because there are peak hours during the day (e.g., early in the morning and the evening) when wastewater is primarily generated. The operation of recycled water facilities would run accordingly and would likely not add substantial noise to existing WWTP operations. Additionally, the existing WWTPs already generate intermittent noise (e.g., from alarm bells, pumps, and generators). It is anticipated there would be a very low probability that sensitive receptors (e.g., residential homes, hospitals, schools) would be located within close proximity to experience the operating noise generated because it is anticipated that the WWTPs would be located in areas with similar land uses (e.g., other public facilities or industrial facilities). Finally, most of the wastewater treatment facilities are enclosed within buildings that reduce the operating noise. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts related to noise. Until such time that these potential mitigation measures are implemented, the impacts

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	would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented depending on the potential location of possible sensitive receptors and given the need to have equipment located within buildings. • Construction of the distribution system would likely exceed noise standards established in local general plans or noise ordinances. This construction would generally occur within road rights-of-way. However, it is not known where distribution lines would be located; they could be located in residential neighborhoods or within immediate proximity to other sensitive receptors (e.g., hospitals, schools, parks). Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts related to noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Once operational, the distribution system would be underground and would transport recycled water to end users. Because new pumping stations would be needed as part of the new recycled water distribution system, operation of these pumping stations could introduce a new noise source, but would generally be enclosed or fenced as to protect it and prevent the public from accessing it. These enclosures would serve to reduce noise and any noise generated would be intermittent throughout the day. As such, the operation of the distribution system is not expected to exceed standards established by a local general plan or noise ordinance. Impacts would be less than significant. • The construction and operation of recycled water facilities would not bring people within close proximity to an airport or expose people to airport noise.
Population and Housing	• The construction and operation of recycled water treatment facilities and distribution systems would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Furthermore, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people to the plan area and extended plan area. Finally, the facilities would be constructed and operated to replace a water source that was reduced (i.e., surface water) rather than increasing capacity to serve new users. Impacts would not occur. • The construction and operation of recycled water treatment facilities and distribution systems would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the facilities would be expected to be located within the footprint of existing WWTPs, and the distribution system would be located in the rights-of-way of existing roads. No homes or people would be displaced. Impacts would not occur.

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Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, the construction and operation of recycled water treatment facilities and distribution systems in the plan area and extended plan area would not involve an increase in population or housing. In addition, these actions would not include proposals for new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.
Recreation	• Construction of recycled water facilities in the plan area and extended plan area would likely occur within the footprint or immediately adjacent to existing wastewater treatment facilities. These facilities are typically located adjacent to receiving waters and in industrial or urban areas to provide wastewater service to the urban, suburban, and industrial users. It is unlikely that recreational facilities would be located in areas near where wastewater treatment facilities currently exist. However, if recreational facilities were located within very close proximity, construction of water recycling facilities may affect them. Construction of the recycled water distribution system would include installing pipeline below grade generally along the rights-of-way of existing roads, and potentially in agricultural fields and other areas (e.g., parks, commercial campus landscapes, golf courses). If installation of pipelines is done in parks or golf courses, use of these areas may be disrupted during construction. However, it is unlikely that there would be significant effects on recreational facilities due to construction of the recycled water treatment facilities and distribution systems because construction would be temporary and limited. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant indirect impacts on recreational resources related to construction activities (noise, air quality, etc.). Impacts would be less than significant. • Construction and operation of recycled water treatment facilities and distribution systems would not require the construction or expansion of recreational facilities. Therefore, potential environmental impacts associated with such construction or expansion would not occur.
Transportation and Traffic	• Construction of recycled water treatment facilities and distribution systems could result in some additional trips associated with construction workers. Wastewater treatment facilities may be located in urban and suburban areas that could already experience some congestion. Similarly, distribution pipelines could be installed in urban and suburban areas for landscape irrigation (e.g., parks, golf courses) where additional trips associated with construction workers may increase existing traffic. The temporary increased traffic during construction could exceed local or regional road trip thresholds. However, the number of construction trips that might be needed is unknown. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant transportation and traffic impacts related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.

Potential Environmental Effects of Developing Recycled Water Sources

Resource	Discussion
	• Operation of recycled water treatment facilities and distribution systems would not generate additional trips beyond those required for existing WWTP maintenance. It is unlikely that operation of the new water recycling facilities would result in a substantial increase in the number of WWTP employees, the amount of traffic generated on a daily basis is not expected to increase. Impacts would be less than significant. • Construction and operation of recycled water treatment facilities and distribution systems would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Construction and operation of recycled water treatment facilities and distribution systems would not be expected to affect the ability to meet the wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of recycled water from a WWTP. The purpose of developing recycled water is to use it as a replacement for other water sources (e.g., potable water, irrigation water), not to dilute WWTP effluent. Additionally, recycled water facilities would not increase the actual volume of wastewater generated in the service area or affect the WWTPs capacity. Impacts would be less than significant. • Construction and operation of recycled water treatment facilities and distribution systems involves construction at wastewater treatment facilities and other areas where the distribution pipelines would be installed. Environmental effects are discussed earlier in this table (Aesthetics through Transportation and Traffic sections). Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant construction or operation impacts related to all environmental resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Operation of recycled water facilities would not need the construction of additional storm water drains because the facilities would likely be built within the footprint of existing WWTPs, which currently have impervious surfaces that generate runoff. It is expected that existing storm water infrastructure would be used. Construction and operation of the distribution system would not require the construction of additional storm water drains because the pipeline would be located underground. Impacts would be less than significant. • Construction and operation of recycled water facilities would not be expected to require a new water supply or increased water supply because these facilities would be treating existing wastewater. Impacts would be less than significant. • Construction and operation of recycled water treatment facilities and distribution systems is not expected to result in a substantial increase in solid waste. WWTPs generate solid waste in the form of biosolids and other byproducts of the treatment stream. While recycled water facilities may also have solid waste, it is anticipated that biosolids would be minimal since they are removed during the wastewater treatment process. Generally, this type of solid waste is not considered hazardous, and the disposal of it follows all regulations and guidelines of solid waste at normal landfills. Impacts would be less than significant.

16.2.5 In-Delta Diversions

Reductions in surface water diversions are possible as a result of approving an LSJR alternative and the respective program of implementation. These reductions in surface water could potentially affect SFPUC by reducing some portion of its current water supply obtained from the Tuolumne River during a 6-year drought, as described in Appendix L, *City and County of San Francisco Analyses*. Under certain LSJR alternatives (i.e., higher unimpaired flow LSJR Alternatives 3 and 4), SFPUC may need multiple new water supplies to augment its current drought supply. As described in SFPUC documents, specifically the Water Supply Options (WSO) report (SFPUC 2007), SFPUC has several options for augmenting or increasing its water supply including diverting water from the Sacramento–San Joaquin Delta (Delta). The SFPUC WSO report was developed in support of the SFPUC WSIP prepared by SFPUC to increase reliability of the regional water system that provides water to San Francisco and neighboring communities (SFPUC 2008). In the 2008 WSIP Programmatic Environmental Impact Report (PEIR), SFPUC concluded that the in-Delta diversion option was infeasible, in part, because it would not achieve consistent year-round diversions due to uncertainties regarding the availability of water supplies and pumping capacities (SFPUC 2008). Nonetheless, a discussion of this possible water supply option has been included in light of the changing circumstances since 2008 (e.g., Pelagic Organism Decline, climate change, California WaterFix, and the State Water Board's *Final Report on the Development of Flow Criteria for the Sacramento Delta Flow Criteria* [State Water Board 2010]).

This section uses information regarding a delta diversion project as was analyzed in the WSO report to evaluate costs and potentially significant environmental impacts. The project as described in the WSO report has a design capacity of 28,000 acre-feet per year (AF/y) and would require relatively little new infrastructure. This design capacity would replace a portion of the supplies potentially reduced by the higher range of the LSJR alternatives (i.e., LSJR Alternative 4) and would likely be needed in addition to other supplies under certain LSJR alternatives given the amount of water potentially needed by SFPUC (see Appendix L, *City and County of San Francisco Analyses*). A delta diversion project would potentially allow SFPUC to use any of the rivers that flow into the Delta as a water supply source, instead of the Tuolumne River. Under this type of project, it is anticipated water would be purchased from any user upstream from the Delta or from a State Water Project (SWP) or Central Valley Project (CVP) contractor south of the Delta. A new connection to either the California Aqueduct or the Delta-Mendota Canal would be constructed to accommodate the transfer. Water would be pumped by the Projects (the SWP and CVP) from the Delta and would be treated and introduced to the system at Tesla Portal. Infrastructure requirements would include diversion from aqueduct, treatment facilities, and modification of Tesla Portal.

Cost Evaluation

SFPUC estimated a delta diversion project with a design capacity of 28,000 AF/y to cost about $306.1 million for capital cost, $7.8 million for annual operation and maintenance costs, and $357.1 million for lifecycle costs (SFPUC 2007). For a project of 28,000 AF/y, this results in approximately $255 per AF over the 50-year lifecycle. The cost per AF of additional water from a delta diversion for a larger project could be less than $255 per AF because of the economies of scale (i.e., the larger infrastructure projects are, the less they cost per unit per year). These costs do not include the cost of purchasing the water from willing sellers to supply the diversion project. Purchase costs would vary depending on market conditions, entities selling the water, and water-year conditions (i.e., drought), but could range from about $50 to $600 per AF, which could result in costs of $1.4–$16.8 million per year (PPIC 2011, Maven's Notebook 2015).

Environmental Evaluation

Summary of Potential Action

The precise location, size, timing of construction, and details of a delta diversion project cannot be known at this time. It is assumed that the project would be carried out by SFPUC; however, other service providers in the region may partake in a joint effort which may increase overall efficiency and reduce costs per unit water diverted. The size of the project may need to be larger than what was examined in the WSO report which is summarized below.

Water diverted from the Tuolumne River is unfiltered and delivered directly to customers after disinfection at the Tesla Portal near Tracy. Any water diverted from the Delta would need to be fully treated before it is blended with Hetch Hetchy water. The project, as outlined in the WSO report (SFPUC 2007), would include a new Delta intake and pumping plant, a new pipeline, a new Delta water treatment plant, and a new blending facility at Tesla Portal.

The intake facilities would draw from the California Aqueduct or the Delta-Mendota Canal. The intake would require a right-of-way purchase and permits to penetrate the aqueduct levee. The pumping capacity would be about 100 million gallons per day (mgd) operating against a head of 180 ft. The pumping plant would be large enough to house five 1,400 brake horsepower (bhp) vertical turbine pump units. Water would be conveyed from the pumping plant to the treatment facilities via a new 60-inch diameter welded steel pipe about 4 miles long. This new pipeline would run parallel to the existing San Joaquin Pipeline and would be within the Hetch Hetchy right-of-way. The new pipeline would be routed through agricultural land but would need to cross Interstate 580. SFPUC's report describes the new Delta water treatment plant as having a 100 mgd capacity and requiring about an 18-acre footprint. The site would be located within SFPUC property boundary just north of the Tesla Portal. A blending facility would be located at Tesla Portal to blend the newly treated water with the disinfected Hetch Hetchy water before being delivered through the existing system.

Potential Environmental Effects

Construction of any diversion and treatment facilities would likely result in temporary, and localized effects typically associated with similar activities including air quality effects and ground disturbance.

Effects associated with exporting water from the Delta are being debated and analyzed by U.S. Bureau of Reclamation (USBR), DWR, and various fisheries agencies as part of the California WaterFix process. If water was purchased from a south of Delta contractor there would be no increase in Delta exports. If water was purchased from a contractor upstream of the Delta, there may be an increase in Delta exports, which could affect Delta fish. This effect would likely be very small due to the size (39 cfs to SFPUC versus 10,000 cfs of combined exports) and would be minimized by operating under current fisheries agencies and State Water Board regulations and requirements.

Potable water treatment and pumping facilities are typically relatively energy intensive; however, the overall increased electrical load would be extremely small compared to the existing electrical load from the large Delta export pumps. Therefore, it is unlikely to require the construction of major new power generation or transmission facilities. The operation of Delta diversion facilities may require a slight increase in chemical transport and storage; however, because the facilities would likely be constructed within or adjacent to existing treatment facilities, the increase would be negligible compared to existing chemical use and transport at these locations.

The Delta diversion facilities would be constructed in areas that are already disturbed by urban development, and most facilities would be located within existing facility footprints and rights-of-way. In addition, because such facilities are publicly owned and subject to CEQA and other environmental regulations, depending on site-specific conditions, any new water treatment projects would undergo the appropriate level of CEQA and other required regulatory compliance at the time they are proposed.

As part of the WSO report, SFPUC prepared a preliminary analysis of environmental effects of a conceptual Delta diversion facility (SFPUC 2007). The analysis identified environmental commitments and/or potential mitigation measures to be implemented by SFPUC to reduce potentially significant impacts for the following resources: aesthetics, agriculture, air quality, biological resources, cultural resources, geology and soils, GHG emissions, hazards and hazardous materials, hydrology and water quality, land use and planning, noise, transportation and traffic, and utilities and service systems. Attachment 2 of Appendix H, *Supporting Materials for Chapter 16*, contains the analysis of the conceptual plan and is incorporated into this evaluation. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, lists potential mitigation measures that SFPUC can and should implement to reduce potentially significant environmental effects on the environmental resources identified in Attachment 2 of Appendix H, *Supporting Materials for Chapter 16*. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, similar to construction impacts disclosed in Section 16.2.4, *Recycled Water Sources for Water Supply*, it is likely impacts related to the construction of facilities could be mitigated to less than significant once mitigation measures were implemented. This is because of the temporary nature of construction, the relative short duration of construction, and that construction would generally occur within existing facility footprints or the public right-of-way. However, the generation of GHGs during construction and operation over the lifetime of the project may not be lessened with mitigation measures and as such, may result in exceedances of existing air quality management basin thresholds resulting in GHG impacts and utilities and service system impacts that cannot be mitigated to less than significant levels.

16.2.6 Water Supply Desalination

Reductions in surface water diversions are expected as a result of approving an LSJR alternative and the program of implementation. These reductions in surface water could potentially affect SFPUC by reducing some portion of their current water supply obtained from the Tuolumne River during a 6-year drought as described in Appendix L, *City and County of San Francisco Analyses*. Under certain LSJR alternatives (i.e., higher unimpaired flow LSJR Alternatives 3 and 4), SFPUC may need multiple new water supplies to augment their current drought supply. One option is desalination of ocean or brackish water. The WSO report addressed potential challenges or issues associated with constructing and operating a year-round desalination facility (capacity of 28,000 AF/y) near the existing Oceanside Water Pollution Control Plant in San Francisco (SFPUC 2007). In the WSIP PEIR (SFPUC 2008), the Oceanside site, along with two other alternative locations, were identified as potential sites for desalination in drought years as part of the Bay Area Regional Desalination

Program (BARDP). SFPUC included the BARDP in the WSIP PEIR analysis as part of a "variant" of the WSIP. The BARDP would involve a partnership among five regional water agencies—SFPUC, Contra Costa Water District (CCWD), East Bay Municipal Utility District (EBMUD), Santa Clara Valley Water District (SCVWD), and Zone 7 Water Agency (Zone 7). In addition to the WSIP PEIR analysis of the BARDP, feasibility studies evaluating various sites, a site-specific pilot study and other site-specific analyses have been completed for the BARDP since 2003. Following the Institution Feasibility Analysis, the participating water agencies concluded that the Oceanside site and the Bay Bridge site in Oakland were not feasible (CCWD et al 2016). Presently, water supply desalination is being considered for all hydrologic year types under the BARDP at Mallard Slough in the Delta, with an estimated production of 20,900 AF/y (CCWD 2014).

This section presents information regarding a desalination project (maximum capacity of 28,000 AF/y) provided in the Bay Area Regional Desalination Project Site Specific Analyses Final Report (CCWD 2014), the Final Draft Bay Area Regional Desalination Project Greenhouse Gas Analysis (Kennedy/Jenks Consultants 2013), and the WSIP PEIR (SFPUC 2008), as well as information for the Poseidon Desalination Facility in Carlsbad (capacity of 56,000 AF/y). The cost and environmental evaluation for the BARDP presented in the following sections are based on information from site-specific pilot studies and feasibility studies, and assumes the BARDP desalination plant and intake to be located at the existing Mallard Slough intake/pump station site.

A desalinization project would provide a reliable water supply regardless of the water year type or other surface water supplies used by SFPUC. A desalinization project would likely need to be larger than analyzed in the WSO report, or the BARDP feasibility studies, for LSJR Alternatives 3 and 4. Therefore, costs and environmental impacts associated with the larger Poseidon Desalination Facility in Carlsbad are also provided below.

Cost Evaluation

The State Water Board analyzed the potential water needed in the service area of SFPUC during a 6-year drought sequence (Appendix L, *City and County of San Francisco Analyses*). The analysis determined SFPUC may need to replace between 13,800 AF/y and 207,810 AF/y during a 6-year drought sequence. The conveyance and storage options being considered for the BARDP would involve the use of CCWD's Mallard Slough, Transfer, Old River, and Middle River pumping plants and CCWD's Old River, Transfer, and Los Vaqueros pipelines, as well as storage in Los Vaqueros Reservoir. CCWD developed a cost estimate for the BARDP use of the Mallard Slough Pump Station, conveyance to Los Vaqueros storage, storage in Los Vaqueros, and delivery from storage to the Mokelumne Aqueduct. Those cost estimates are provided in Table 16-11a, *Cost Estimates for BARDP Use of Existing Water Conveyance and Storage Facilities*.

Table 16-11a. Cost Estimates for BARDP Use of Existing Water Conveyance and Storage Facilities

BARDP Component	Estimated Cost ($/AF/y)
Use of Mallard Slough Pump Station and associated water rights	$86–$121
Conveyance to Los Vaqueros Reservoir	<$1
Storage in Los Vaqueros Reservoir	$70–$105
Delivery from Los Vaqueros Reservoir[a]	$16

Source: CCWD 2014.

BARDP = Bay Area Regional Desalination Project.

AF/y = acre-feet per year.

[a] Cost does not include the East Bay Municipal Utility District's costs for wheeling water through their system for final delivery to other BARDP participating water agencies.

In 2010, a cost estimate was prepared as part of a pilot study at the Mallard Slough Pump Station. It was estimated that the capital cost for a facility that would use 28,000 AF/y of brackish or ocean water to produce approximately 22,175 AF/y of treated water, including the intake and pipeline for conveyance to the existing conveyance system, would be $168 million, or approximately $8.50 per gallon per day. This includes contingencies and planning, permitting, engineering, and administrative costs. The annual operating cost was estimated at approximately $10.5 million (MWH 2010).

Current desalination projects under development in California have estimated costs between $1,000 and $3,000 per AF (WaterReuse 2012, SDCWA 2015). Poseidon Resources is currently developing the Carlsbad Desalination Project, and will own and operate the facility after construction is completed. However, the County of San Diego has the option to purchase the plant in 30 years. A purchase agreement for water from the plant is in place and water is expected to cost between $1,849 and $2,064 per AF in 2012 dollars (SDCWA 2015). Based on total costs per AF of other desalination facilities in California (WaterReuse 2012, SDCWA 2015) it is estimated that the total cost for water produced would be between $1,000 and $2,200 per AF.

Environmental Evaluation

Summary of Potential Action

The BARDP would entail diverting water from the Delta through an existing intake at the CCWD Mallard Slough Pump Station (available capacity up to 40 mgd subject to existing water rights, terms and conditions) through existing pipelines to a proposed desalination plant for treatment. The desalination plant and connections to the existing water conveyance network in the region are the only new infrastructure anticipated for the project. The desalination plant is expected to draw a constant 21 mgd of water. Treated water from the new BARDP desalination plant would be conveyed via CCWD's Multi-Purpose Pipeline for delivery to CCWD customers or the Mokelumne Aqueduct for delivery to EBMUD's water treatment plants and subsequent delivery to the participating water agencies, or both (Kennedy/Jenks Consultants 2013). Based on pilot project results, it is assumed that the brine stream from the new desalination plant would be a constant 20 percent of the diverted 21 mgd, or approximately 5 mgd (CCWD 2014). Two potential existing WWTPs have been identified to dispose of the brine originating from the desalination treatment process: Central Contra Costa Sanitary District (CCCSD) and Delta Diablo Sanitation District (DDSD). It is estimated that given the current the dry weather discharge capacities of CCCSD and DDSD, CCCSD would have the capacity to accept the brine through 2030 (CCWD 2014).

BARDP desalinated water production would exceed participating water agencies' demands in non-drought years, but would fall short of the higher combined demands in drought years. Excess BARDP water production would be stored in Los Vaqueros Reservoir in non-drought years through an exchange with CCWD, and the stored BARDP water would be released from the reservoir in drought years. The minimum BARDP demand would be approximately 14 mgd in all years. EBMUD, SCVWD, and CCWD BARDP water demand would occur less frequently and is based on hydrologic year type as well as other factors, but estimated demand could be as high as approximately 46 mgd in some drought years. In drought years, the demand of all five water agencies could not be met with only BARDP production. However, unused production stored via exchange in Los Vaqueros Reservoir during non-drought years (maximum 4.6 mgd) could augment deliveries in drought years. CCWD estimated over an 82-year CalSim II modeling period that the combined demand of SFPUC, EBMUD, SCVWD, CCWD, and Zone 7 is 1,754 thousand AF (TAF) and the maximum BARDP production would be 1,714 TAF. Accordingly, approximately 98 percent of the combined demand could be met. This is considered an upper limit that assumes all excess BARDP production could be stored in Los Vaqueros Reservoir (CCWD 2014).

Potential Environmental Effects

As part of the WSIP PEIR, SFPUC prepared a conceptual-level, generalized impact analysis of the BARDP, which, at the time of the analysis, was based on limited, preliminary information regarding project design and operation, and site location. Because of this limited project-specific information, it was generally determined that most of the potential impacts associated with construction and operation of a desalination plant and associated facilities would be potentially significant for the following resources: land use and visual quality; geology, soils, and seismicity; air quality; cultural resources; GHG emissions; hazards; noise and vibration; traffic, transportation, and circulation; public services and utilities; recreational resources; and agricultural resources (SFPUC 2008). However, for these resources it was presumed that potentially significant impacts could be avoided or reduced to a less-than-significant level through site selection, project design, and implementation of "environmentally-sensitive" construction and operation techniques or through implementation of mitigation measures (SFPUC 2008). With respect to mineral resources and population and housing that were not evaluated by the WSIP PEIR, it's anticipated that impacts would not occur under construction and operations. This is because the desalination facilities would not result in a loss of mineral resources. In addition, the facilities would not be built to accommodate an increase in population in the service area and would not include housing or other amenities that might result in an increase in population. Construction and operation of the BARDP would require substantial nonrenewable energy resources and although some of the impacts could potentially be mitigated through project design with application of energy-saving technologies, impacts were considered significant and unavoidable to be conservative (SFPUC 2008). It was determined in the WSIP PEIR impact analysis that operation of the BARDP would result in potentially significant and unavoidable impacts on hydrology and water quality, biological resources, and energy resources. Although potential water quality impacts due to brine and associated impacts on biological resources (specifically, aquatic resources including special-status species) for the BARDP could potentially be mitigated through design/operation, mitigation measures, and regulatory compliance, the impact was considered significant and unavoidable, to be conservative (SFPUC 2008). Attachment 3 of

Appendix H, *Supporting Materials for Chapter 16,* contains a summary of the impacts, mitigation measures, and SFPUC construction measures applicable to the BARDP. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, as noted by the WSIP PEIR, significant impacts associated with the following resources could likely be reduced to less than significant with the implementation of mitigation measures: land use and visual quality; geology, soils, and seismicity; air quality; cultural resources; GHG emissions; hazards; noise and vibration; traffic, transportation, and circulation; public services and utilities; recreational resources; and agricultural resources.

BARDP feasibility studies done for a desalination facility at the Mallard Slough intake analyzed potential water quality impacts of operating the desalination facility and brine disposal, as well as the potential impacts on sensitive fish populations due to operating the facility (CCWD 2014). In addition, the study estimated GHG emissions associated with operation of the desalination facility and water conveyance to participating water agencies (Kennedy/Jenks Consultants 2013). Based on water quality modeling, it was determined that changes in ambient water quality associated with BARDP operations and brine disposal at CCWD or DDWD were too small to be accurately measured in the field, and that during most conditions, operations would not have a significant impact on water quality or beneficial uses (i.e., municipal water supply, wildlife, agriculture). Further, during critically dry water years, BARDP operations would need to be coordinated with CVP, SWP, and the City of Antioch[14] operations to avoid impacts (CCWD 2014). Construction of the BARDP would produce one-time estimated GHG emissions associated with the use of construction equipment and vehicles. As estimated by the GHG analysis performed for the BARDP, facility operations would produce approximately 9,200 MT CO_2e emissions (Kennedy/Jenks Consultants 2013). Potential GHG reduction measures/projects identified in the 2013 GHG analysis for the project included: green building design, pump energy optimization program, commercial/residential rebates (solar hot water heater program), invest in large-scale renewable energy, local solar photovoltaic projects, fleet fuel reduction, GHG offset purchases, and wetlands restoration (Kennedy/Jenks Consultants 2013).

A facility that is larger than the BARDP (e.g., 56,000 AF/y) would have similar types of construction and operation impacts. The types of construction activities associated with a large desalination facility with a capacity of 56,000 AF/y would be similar to those required for a smaller facility like the BARDP and would likely result in temporary, and localized effects typically associated with similar activities including air quality effects and ground disturbance. Long-term operational impacts associated with a large desalination facility with a capacity of 56,000 AF/y would be similar in nature to those described in the feasibility studies as well as in the WSIP PEIR for the BARDP, and are primarily related to marine life entrainment, brine outfall, and impact on open space and recreation areas. Desalination facilities are typically relatively energy intensive. The increased electrical demand as a result of a larger design capacity (i.e., increase from 28,000 to 50,000 AF/y) could result in increases in GHG emissions and air quality impacts under operating conditions. The operation of desalination facilities may require a slight increase in chemical transport and storage, but as the facilities would likely be constructed within or adjacent to existing treatment facilities, the increase would be negligible compared to existing chemical use and transport at these locations.

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[14] The City of Antioch has an intake in close proximity to the proposed BARDP facilities.

While there are many geographic differences between the San Francisco Bay–Delta and Carlsbad, similar environmental impacts were identified for the project-level analysis of the Carlsbad facility (City of Carlsbad 2015). Cumulative regional impact on air quality for the production of ozone and PM10 were determined to be significant and unavoidable. The following resources were identified as less than significant after mitigation for the Carlsbad facility: cultural resources, hazards and hazardous materials, hydrology and water quality, land use and planning, and traffic and circulation.

16.2.7 New Surface Water Supplies

Reductions in surface water diversions are expected as a result of implementing an LSJR alternative. As such, some water suppliers may explore the feasibility of constructing and operating on- or off-stream reservoirs to obtain new surface water supplies. However, new reservoirs present unique technological challenges that require extensive engineering, biological, and environmental studies to evaluate the feasibility of constructing, operating, and maintaining them. Amongst many considerations, the feasibility of constructing and operating a surface water reservoir depends on the implementation of an LSJR alternative and whether water is available in the Stanislaus, Tuolumne, and Merced River Watersheds for such use.

It is likely that the implementation of the LSJR alternatives would reduce surface water availability on the Stanislaus, Tuolumne, and Merced Rivers. With more water devoted to instream flow requirements, existing surface water reservoirs on these rivers would receive less water relative to current conditions. As such, any new surface water reservoir would be in competition with older reservoirs that likely have senior water rights. If the new reservoir could not capture enough storage, or generate enough hydropower, to outweigh the costs of construction and operation, it may be deemed infeasible. Furthermore, some parts of the Upper Stanislaus, Tuolumne, and Merced Rivers Watersheds are fully appropriated, meaning all available water has been claimed. Specifically, 8 percent of the Upper Stanislaus River Watershed, 3 percent of the Upper Tuolumne River Watershed, and 14 percent of the Upper Merced River Watershed are fully appropriated. This would constrain potential locations for a new surface water reservoir and potentially limit the volume of water that could be stored. In addition, planning and constructing new surface water reservoirs would likely not occur within a reasonable timeframe to augment or provide new water supplies in the foreseeable future. For example, Tuolumne Utilities District (TUD) is considering a backup reservoir for one of its current water delivery flumes in its service area on the Stanislaus River and has estimated it could be built and filled within the next 10 years (The Union Democrat 2016). In addition, the Temperance Flat Reservoir on the Upper SJR has been contemplated, discussed, and evaluated for over 15 years (Friant Waterline 2014). These projects typically have incredibly long-lead times because multiple pre-project studies for engineering, environmental, and economic analyses would be required before any construction could begin. These studies would need to show that a proposed on- or off-stream reservoir in the eastside LSJR tributary watersheds could be constructed and operated with an estimated average annual water supply yield and associated benefits to justify the cost. Given the above, the likelihood of constructing and operating a new surface water reservoir is low. However, general costs associated with constructing and operating new reservoirs are still evaluated below, as well as environmental resources for which there could be a significant and unavoidable impacts. The environmental analysis does not include the construction of new reservoirs within Yosemite National Park because it is not reasonably foreseeable.

Cost Evaluation

The costs associated with constructing and operating a reservoir depend on numerous factors including, but not limited to: its potential location, the size of the reservoir, the type of demand to be served, the infrastructure needed to convey stored water to end users, and the regulatory and political climate.

Within the state, several reservoirs are in the planning stage, including the Temperance Flat Reservoir, which would be located in Fresno and Madera Counties between Friant Dam and Kerckhoff Dam, on the Upper SJR (SJVWIA 2016). The total estimated investment cost for the Temperance Flat Reservoir is $2.5–$2.8 billion (USBR 2014a, SJVWIA 2016). The project would include a dam at river mile (RM) 274 on the Upper SJR, diversion and outlet works, a low-level intake structure, valve house, powerhouse, transmission facilities, and access roads (USBR 2014a). Total annual costs once the dam and reservoir are operational would be approximately $116–$121 million. This cost would include operation and maintenance for the reservoir facilities, hydropower mitigations, and net additional CVP and SWP power costs (USBR 2014a). The estimated annual cost does not include water conveyance costs beyond the net power requirement for delivering the new water supply (USBR 2014a).

The California Water Commission (CWC) has been accepting concept papers for other potential new reservoirs or reservoir expansions across California in preparation for funding projects with Proposition 1. Three of these projects were proposed by TUD to serve Tuolumne County and would be located on tributaries to the Stanislaus River above New Melones. Given that the details of the projects are not yet known, it is speculative to analyze them prior to the project proponent's funding, approval, and design; however, they are provided here as comparison points to the Temperance Flat Reservoir. The three projects are the expansion of the Herring Creek Reservoir, Sierra Pines Reservoir, and Upper Strawberry Reservoir, with expected costs of $150 million, $40 million, and $120 million, respectively (TUD 2016a, TUD 2016b, TUD 2016c). However, none of these proposals included justification of additional water supply to meet demand, rather they cited water supply reliability in the event of an unanticipated need. The expansion of the Herring Creek Reservoir would include construction of a 130-foot high dam to store 11,000 AF on Herring Creek, a tributary to the South Fork of the Stanislaus River, because the current reservoir is silted and abandoned (TUD 2016a). The Sierra Pines Reservoir proposal would construct and operate an 850 AF reservoir and recreational area at the existing confluence of the Pacific Gas and Electric Company (PG&E) Tuolumne Main Canal and the TUD Section 4 Ditch. It would not add to the existing water supply of TUD, but rather would be used in the event that there is a critical distribution outage. This proposal is undergoing feasibility studies, but the water source to fill this reservoir would come from an existing contract with PG&E for diversions out of the Tuolumne Main Canal (TUD 2016b). The Upper Strawberry Reservoir proposal would include constructing a 120-foot high dam to store 6,000 AF just above Pinecrest Lake (TUD 2016c).

Environmental Evaluation

Summary of Potential Action

It is unknown exactly how surface water users would respond to a reduction in their surface water supply as a result of the program of implementation and the potential of developing surface water storage is low because of the limits on available water supplies. Further, it is not possible to estimate the construction parameters of potential reservoirs here because their construction will depend on too many factors unknown at this time. However, the Temperance Flat Reservoir can be used as an example for describing the construction and operation of a potential reservoir, given that Temperance Flat would be located on the Upper SJR Watershed. Using the Temperance Flat Reservoir as an example does not mean it would be constructed or operated. It is simply used to provide context for the type of significant environmental impacts that could occur if new surface water reservoirs were constructed and operated. Any project-specific conditions for this reservoir or other surface water reservoirs that may be constructed and operated would need to be considered, analyzed, and mitigated. For example, Temperance Flat is a significantly larger reservoir than the three reservoirs described in the concept papers by TUD. As such, smaller reservoirs would likely result in smaller construction and operation footprints and thus have reduced or fewer impacts when compared to larger projects, such as Temperance Flat. In addition, reservoirs constructed in different locations than Temperance Flat with a different physical environment would have different impacts and mitigation measures to accommodate those physical environmental conditions.

The Temperance Flat reservoir and dam, if constructed, would be built in the upstream portion of Millerton Lake on the SJR. The reservoir would provide approximately 1,260 TAF of additional storage capacity and increased water supply reliability. In addition, it would improve system operational flexibility for agricultural, urban, and environmental purposes in the CVP's Friant Division, as well as in other San Joaquin Valley areas and other regions of California (USBR 2014b).

Currently, a preferred alternative for the Temperance Flat reservoir project has not been chosen, and five alternatives, including a no action alternative, have been analyzed in the Draft Environmental Impact Report (DEIR) for the project. All action alternatives adjust Friant Dam operations for delivery of new water supplies via the SJR to Mendota Pool. The action alternatives also propose modifying the timing and quantity of water diverted to Madera and Friant-Kern canals, which would increase water supply reliability to Friant Division contractors and provide opportunities for groundwater banking. Further, the action alternatives would improve conjunctive management in the Friant Division of the CVP by increasing incidental groundwater storage and/or recharge. The action alternatives primarily differ in terms of carryover storage for Millerton Lake and Temperance Flat Reservoir, beneficiaries and routing of new water supply, and type of intake. (USBR 2014b).

Potential Environmental Effects

If the construction and operation of a new dam and the Temperance Flat Reservoir proceeds, it would result in temporary and permanent environmental impacts. Significant and unavoidable construction- and operations-related impacts were identified for the following resources in the DEIR: air quality and GHG emissions; fisheries and aquatic ecosystems; botanical and wetlands resources; wildlife; cultural resources; paleontological resources; geology and soils; land use, planning and agricultural resources; transportation; noise; energy; recreation; and visual resources (USBR 2014b). Impacts that were mitigable to a less-than-significant level were identified for the following resources: air quality, botanical and wetlands resources, wildlife, paleontological resources, surface water quality, geology and soils, transportation, recreation, public health and hazardous materials, and utilities and service systems (USBR 2014b).

Table 16-11b, *Potential Environmental Effects of New Surface Water Supplies*, summarizes the potential environmental effects of the Temperance Flat Reservoir as well as the potential impacts of construction and operation of a large reservoir on the Stanislaus, Tuolumne, or Merced Rivers upstream of the rim dams. As noted above, it is not reasonably foreseeable that new reservoirs would be constructed within Yosemite National Park; therefore, such reservoirs are not analyzed. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this action and is referenced in Table 16-11b, where appropriate.

Table 16-11b. Potential Environmental Effects of New Surface Water Supplies

Potential Environmental Effects of New Surface Water Supplies	
Resource	Discussion
Aesthetics	• Construction of new surface water supplies (dams and associated storage reservoir) would be expected to significantly affect the visual character or quality of areas because construction would be a multi-year process with major excavation for the dam footprint, excavation of major aggregate source areas at or near the site, creation of multiple access roads to the new dam and associated structures for personnel and equipment access, clearing and grading for equipment staging areas, clearing and grading for onsite, temporary construction buildings, nighttime lighting for construction, safety and security, and cutting of all trees that would be in the reservoir inundation zone. Once the dam was completed, reservoir filling for dam stability testing would convert the natural river canyon scenery to a placid lake. Construction and operation of new surface water storage facilities may have operational, security and safety lights. Impacts would depend on the location of sensitive receptors to potential lighting; however, lights would be expected to follow lighting guidelines and lighting plans of local jurisdictions approving the construction and operation of the new surface water storage facilities. Table 16-38 identifies potential mitigation measures lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant environmental effects associated with lighting. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • If new surface water reservoirs were constructed and operated in the portions of rivers designated as National Wild and Scenic River (83 miles of the Tuolumne River: 47 miles wild, 23 miles scenic, 13 miles recreational) or studied as potentially eligible (Stanislaus River) then the impacts would be significant and unavoidable. The impacts would be significant and unavoidable because of the substantial change to the visual character and quality of the surrounding area from natural river canyon scenery to a placid lake and there is no mitigation available that would reduce these aesthetic impacts to less than significant.
Agriculture and Forestry Resources	• Construction and operation of new surface water storage facilities would not be expected to take place on lands used for agriculture (including Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) because there is limited agricultural land adjacent to the river systems where new reservoirs might be built. Impacts would be less than significant. • Construction and operation of new surface water facilities could affect forestry resources, either private forest lands or federal National Forest System lands (e.g., Stanislaus National Forest) because most of the potential reservoir sites partially overlap forest vegetation zones. As such, there would be a conflict with existing zoning for forest land and potentially timberland, and potentially a loss or conversion of forest land to non-forest use. Table 16-38 identifies potential mitigation measures lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant environmental effects on forestry resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. If forest land or timberland is permanently removed from production due to construction and operation of new surface water facilities, then it is likely impacts would not be fully mitigated and would be significant and unavoidable.

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
Air Quality	• It is expected that a new surface water reservoir would be located upstream of the existing rim dams, and potentially in the MCAB, and the GBVAB. New surface water storage facilities and associated recreation facilities could be located in these air basins. This could occur within the jurisdictions of CCAPCD, the GBUAPCD, MCAPCD, and TCAPCD. For projects within CCAPCD jurisdiction a significant impact would occur if project emissions are greater than 150 pounds per day for ROG, NO_X, or PM10 in either the construction or operational periods. No thresholds for other criteria pollutants or their precursors have been established by the CCAPCD. The GBUAPCD does not have adopted quantitative thresholds of significance for criteria pollutants for proposed projects for the purposes of CEQA, although thresholds from neighboring air districts (e.g., CCAPCD, TCAPCD, SJVAPCD) may be used to evaluate impacts within the GBUAPCD. For construction impacts, the GBUAPCD requires that project proponents adopt comprehensive mitigation measures to mitigate fugitive dust impacts. For emissions associated with the operation of stationary sources, the GBUAPCD considers stationary emissions to be less than significant if they are exempt from Rule 202 pursuant to Rule 209-A(B)(2). Rule 209-A identifies emission limits of 250 pounds per day for ROG, NO_X, SO_X, and particulate matter. For projects within MCAPCD jurisdiction a significant impact would occur if project operational emissions are greater than 100 tons per year for ROG, NO_X, CO, SO_X, PM10, and PM2.5 (County of Mariposa 2006). For projects within TCAPCD jurisdiction a significant impact would occur if project emissions are greater than 100 tons per year or 1,000 pounds per day for ROG, NO_X, CO, and PM10. If SJVAPCD requirements are used their published guidelines, *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), do not require the quantification of construction emissions. Rather, the guidelines require implementation of effective and comprehensive feasible control measures to reduce PM10 emissions (SJVAPCD 2002). SJVAPCD considers PM10 emissions to be the greatest pollutant of concern when assessing construction-related air quality impacts and has determined that compliance with its Regulation VIII, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), constitutes sufficient mitigation to reduce construction-related PM10 emissions to less-than-significant levels and minimize adverse air quality effects. All construction projects must abide by Regulation VIII. Further consultation with SJVAPCD staff indicates that, though explicit thresholds for construction-related emissions of ozone precursors are not enumerated in the *Guide for Assessing and Mitigating Air Quality Impacts*, SJVAPCD considers it a significant impact when construction or operational emissions of ROG or NO_X exceed 10 tons per year or if PM10 or PM2.5 emissions exceed 15 tons per year (Siong pers. comm.). • Construction of new surface water storage and recreation facilities would result in emissions associated with: general construction equipment, concrete batch plants, heavy-duty off-road equipment, materials transport in haul trucks, worker commute to the site, and increases in recreational visitors to the area. The amount of criteria air pollutant emissions would be less if amortized over the total life of the project (i.e., total daily or yearly emissions would be averaged over a longer time interval). Fugitive dust emissions would occur from exposed soils during the construction period. Depending on the level of activities and amount of infrastructure built, construction of new surface water storage facilities could exceed air quality thresholds established by applicable APCDs and would be required to implement measures to help reduce or minimize construction-related emissions. Lead agencies (e.g., state or federal agencies, utility districts) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
	on air quality from construction-related emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Operation of new surface water storage facilities would result in minimal air quality related emissions because one of the primary activities would be hydroelectric generation. Associated recreational facilities would generate air quality related emissions from vehicle trips, motorized boating or Jet Ski use, and electricity use. However, local electricity use would likely be from the dam hydroelectric facility itself, so there would be no emissions from other region-wide electrical generation. Emissions from vehicle trips, motorized boating or Jet Ski use could result in exceedances of applicable APCDs within the plan area or extended plan area, and could result in a potentially significant impact. Lead agencies (e.g., state or federal agencies, utility districts) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on air quality associated with operational emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • The various APCDs have determined some common types of facilities that have been known to produce odors in the region. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants. Construction and operation of new surface water storage facilities would not involve the type of facility identified by, for example, SJVAPCD, as a known odor source (SJVAPCD 2002). Consequently, it is expected that new surface water storage facilities would not create objectionable odors affecting a substantial number of people. Impacts would be less than significant. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction and operation of new surface water storage facilities would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. Construction and operation of new surface water storage facilities would not result in growth because the facilities would not involve the construction of new homes in the area, the extension of roads, or other infrastructure that may induce substantial property or population growth in an area, and because the storage facilities would be constructed and operated to replace a water source that was reduced (i.e., surface water) rather than to increase capacity to serve new users. Construction and operation of new surface water storage facilities would not result in population or employment growth that would result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Accordingly, this impact is less than significant.

Potential Environmental Effects of New Surface Water Supplies	
Resource	Discussion
Biological Resources	• It is expected that construction and operation of new surface water facilities would be in natural landscapes that could include chaparral, oak woodland, conifer forest and perhaps alpine, depending on location. These areas are expected to have a high potential for special-status plant species, animal species, and habitat (including federally protected wetlands). Additionally, these habitats would be completely replaced by aquatic lake habitats. There is minimal potential to fully mitigate these impacts. In addition, operation of new surface water facilities would result in a change in the flow regime and potentially alter temperature downstream, which could result in impacts to aquatic species. There is also potential that construction or operation of new surface water storage facilities would result in a conflict with an existing local policy or an adopted habitat conservation plan or natural community conservation plan. Reservoir construction within the boundaries of the Stanislaus or Sierra National Forests or the Bureau of Land Management lands could conflict with their existing management direction. Table 16-38 lists potential mitigation measures lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant environmental effects of construction and operations on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even after mitigation, however, impacts would still likely remain significant and unavoidable due to the large scale replacement of habitat with an aquatic lake habitat.
Cultural Resources	• Construction of new surface water storage facilities would likely take place in relatively natural settings, however, these areas have an extensive history of use by Native American tribes and Euro-Americans during and subsequent to the Gold Rush era. Consequently, extensive archaeological and historical resources would likely be disrupted by construction, filling and operation of new surface water storage facilities. Construction may result in ground-disturbing activities which have the potential to disturb or destroy buried, unknown, significant cultural resources (significant historical, archeological, or paleontological resources). Lead agencies (e.g., state or federal agencies, utility districts) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on cultural resources associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even after mitigation, however, impacts would still likely remain significant and unavoidable due to the potential large scale disturbance of the area. • Operation of reservoir facilities has the potential to affect cultural resources during reservoir drawdown which could expose cultural resource sites to discovery and disruption by the general public. Lead agencies (e.g., state or federal agencies, utility districts) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on cultural resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even after mitigation, however, impacts would still likely remain significant and unavoidable due to the potential large scale disturbance of the area. • As described above, it is expected that new surface water storage sites would not have been previously disturbed. Therefore, there is potential that human remains, typically buried at depths of 6 ft, would be disturbed during construction. If, in the highly unlikely event human remains are uncovered during construction, compliance with the State Health and

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
	Safety Code would be required. As specified by Section 7050.5 of the Health and Safety Code, and described in Table 16-38, no further disturbance would occur until the county coroner has made the necessary findings as to origin and disposition pursuant to Public Resources Code Section 5097.98. If such a discovery occurs, excavation or construction would halt in the area of the discovery, the area would be protected, and consultation and treatment would occur as prescribed by law. If the coroner recognizes the remains to be Native American, he or she would contact the NAHC, who would appoint the Most Likely Descendent. Additionally, if the human remains are determined to be Native American, a plan would be developed regarding the treatment of human remains and associated burial objects, and the plan would be implemented under the direction of the Most Likely Descendent. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even after mitigation, however, impacts would still likely remain significant and unavoidable due to the potential large scale disturbance of potential areas.
Geology and Soils	• The locations of new surface water storage facilities could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, the counties in the extended plan area do not contain known Alquist-Priolo faults and are in a zone of low seismic shaking. The new surface water supply facilities could result in an impact on or be affected by expansive soils, or landslides. Landslides could occur on cut slopes created for dam building or from the reservoir side slopes when filled with water. New structures would be required to follow all appropriate building codes and dam design criteria and would be designed to withstand seismic-related activities as identified by the building codes and dam design criteria. Dam design criteria include those from the DWR Division of Safety of Dams (DSOD), federal Dam Safety and Security Act of 2002 (Public Law 107-310), as well as geological engineering, geotechnical engineering, and engineering design standards. New surface water storage facilities would not substantially increase the number of people exposed to the risk of earthquakes since the areas are not in areas with Alquist-Priolo faults or strong seismic shaking. If there was an increase in reservoir side slope instability, people drawn to the reservoir for recreational opportunities would be exposed to that geologic hazard. However, geological engineering and geotechnical engineering studies for new surface water storage facilities would address these potential instabilities. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts related to geology and soils associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the need to follow the building code and other state and federal building and dam design requirements. • The construction and operation of new surface water storage and related facilities would potentially involve constructing or operating septic tanks for construction crews or for post-construction recreation facilities. Therefore, septic tanks could be affected by soils incapable of supporting the use of them or other alternative wastewater disposal systems. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts related to septic tanks associated with construction and operations. Until such time

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
	that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction and the relatively small scale of the recreation facilities. • Construction of new surface water storage facilities would result in substantial ground-disturbing activities that could cause soil erosion or loss of topsoil that would occur with a construction period of multiple years. Ground-disturbing activities of 1 acre or greater would require preparation and implementation of a SWPPP, as required by the Regional Water Quality Control Board. The SWPPP would require soil and erosion control mechanisms for all stages of construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts on soil erosion and storm water runoff associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary, albeit multi-year, nature of construction.
Greenhouse Gas Emissions	• Generation of GHG emissions associated with new surface water storage facilities and associated recreation facilities would result from: general construction equipment, concrete batch plants, heavy-duty off-road equipment, materials transport in haul trucks, worker commute to the site, increases in recreational visitors to the area, and loss of CO_2 sequestration from vegetation that dies within the reservoir inundation zone. The total amount of GHG emissions would be less if amortized over the total life of the project. The following APCDs do not have applicable GHG thresholds: CCAPCD, MCAPCD, TCAPCD. For air districts in which there is no adopted GHG threshold, the ZEL for SJVAPCD could be applied. As such, it is anticipated that increased GHG emissions could exceed the applicable SJVAPCD ZEL threshold and result in a potentially significant impact. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts of construction and operations from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
	AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Construction of new surface water storage facilities would occur over several years and would involve the limited transport, storage, use, and disposal of hazardous materials such as fuel and lubricating grease for motorized heavy equipment. Some examples of typical hazardous materials handling are fueling and servicing construction equipment on the site, and transporting fuels, lubricating fluids, solvents, and bonding adhesives. Operation of hydroelectric generation facilities at the dam would involve various oils and greases for lubrication. These types of materials are not acutely hazardous, and storage, handling, and disposal of these materials are regulated by local, county, and state laws. While the quantities of these materials used during construction would not be small, the amount used at any one time would be small (e.g., less than 100 gallons). Therefore, if a spill occurred, it could be readily and easily contained. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary, albeit multi-year, nature of construction. • The precise location of where new surface water storage facilities would be constructed is not yet known; however, these facilities could be constructed within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation activities. As such, if a school existed within close proximity to construction of new surface water storage facilities, those mitigation measures identified table 16-38 applied to project-specific construction needs would reduce potentially significant impacts during construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction.

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
	• Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962, these sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the DTSC for Alpine, Calaveras, or Tuolumne Counties (i.e., counties where the Stanislaus or Tuolumne Rivers are located) (CalEPA 2016). In addition to these sites identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 62 active open leaking underground storage tanks in these counties (CalEPA 2016). There are approximately 7 facilities in these counties identified as having active CDOs/CAOs (CalEPA 2016). The active and open leaking underground storage tank cases and the CDO/CAO facilities are located throughout these counties. Although it is not yet known precisely where in the extended plan area new surface water storage facilities would be constructed, if they were constructed on a Cortese Site, there would be potential for release and spread of existing soil or groundwater contaminants because construction of new surface water storage facilities would entail substantial excavation. Were release and spread of existing soil contaminants to occur, impacts could be significant. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • Operation of new surface water storage facilities would not involve the use of hazardous materials and impacts would not occur. • Construction and operation of new surface water storage facilities would not be a hazard or cause safety concerns to public or public use airports or private airstrips because the facilities would be constructed and operated within, or immediately adjacent to, the river banks and channels and would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, construction and operation of new surface water storage would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Construction and operation of new surface water storage facilities would not physically interfere with an adopted emergency response plan or emergency evacuation plan. Reservoirs could potentially restrict the mobility of people to escape potential emergencies in the vicinity of the reservoir (e.g., wild fires, forest fires). Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts associated with restricted travel routes during construction or reservoir operations. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction and the fact that there are relatively few road systems in these areas that could potentially be blocked by new reservoirs.

Potential Environmental Effects of New Surface Water Supplies	
Resource	Discussion
	• Construction and operation of new surface water storage facilities would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Because construction would involve substantial clearing of work sites and construction laydown areas, onsite workers would have access to substantial shelter-in-place areas from wildfires during that time. These cleared areas would also be useable by local residents evacuating wildfires in the areas. Impacts would not occur.
Hydrology and Water Quality	• Construction of new surface water storage facilities and associated recreation facilities could result in temporary and permanent changes to drainages, erosion, or runoff associated with typical construction activities, such as grading or preparation of land as well as major excavation and blasting for dam foundation preparation. As discussed earlier in this table (Geology and Soils section), for soil disturbance of over 1 acre, wastewater treatment special districts or municipalities would be required to prepare and implement a SWPPP. In addition, as discussed in this table for Hazards and Hazardous Materials, construction of new surface water storage facilities may involve the limited transport, storage, use, and disposal of hazardous materials, which, if spilled, could have adverse effects on water quality depending on the location and magnitude of the spill. However, storage, handling, and disposal of these materials is regulated by local, county, and state laws, and the quantities of these materials used during construction would be small (e.g., less than 100 gallons) and construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained and, as such, violations of water quality standards are not expected to occur. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts of construction on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary, albeit multi-year, nature of construction. • It is likely that the new surface water storage facilities would be located in a flood hazard area because the dam and reservoir would be within an existing river channel. However, the flood hazard area would be relatively narrow as the dam and reservoir would likely be built in a relatively deep canyon to maximize storage. Once constructed the reservoir area would prevent flooding within the reservoir zone and also provide storage to minimize major floods downstream of the dam. Additionally, construction and operation of the new surface water storage facilities would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to or place housing within flood hazard locations (including 100-year flood hazard areas). Construction and operation of new surface water storage facilities would not expose people to significant loss, injury, or death related to flooding. Impacts would be less than significant. • Construction of new surface water storage facilities would not substantially alter the existing drainage pattern of the site or area, or substantially increase the rate or amount of surface runoff such that the new surface water storage facilities would result in flooding or otherwise cause flooding, or create or contribute runoff water. New structures would be required to follow all appropriate building codes, dam design criteria, and engineering design standards, which would address drainage of the site. Impacts would be less than significant. • Operation of new surface water storage facilities and associated recreation facilities would not likely contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems. However, because there

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
	would potentially be an increase in impervious surfaces associated with new recreational facilities (e.g., restrooms), stormwater runoff could increase. Table 16-38, under “Geology and Soils” lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts of recreational facility operation related to storm water runoff and drainage. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction of new surface water storage facilities and associated recreation facilities would not increase the volume of treated effluent discharged into receiving waters. This is because effluent would be treated via septic systems or contained in closed vault toilet systems. Therefore, it is expected that hydrology would not be affected. However, since these facilities may use septic systems, Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts of reservoir construction and operations and recreational facility operation related to septic systems. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Increases in groundwater pumping are not expected to occur under the construction and operation of new surface water storage facilities because such facilities would only pump groundwater to locally dewater wet areas during construction. Because construction of new surface water storage facilities would not result in a substantial increase in impervious surfaces and therefore would not interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or lowering of the local groundwater table. Impacts would be less than significant. • Construction and operation of new surface water storage facilities would primarily be located in areas of relatively steep relief because they would be within deep river canyons. Therefore, these locations would support mudflows, which typically need very steep slopes and large amounts of precipitation to occur. Additionally, reservoir filling would potentially increase landslides and mudflows from the steep reservoir side slopes as they were saturated by reservoir water. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts of reservoir construction and operations and recreational facility operation related to landscape instability. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • New surface water storage reservoirs are not expected to experience sufficient seismic ground shaking to generate in-reservoir seiches that could inundate recreational sites. However, large fast landslides into the reservoir could generate splash waves that would affect recreational sites along the reservoir. The potential for these large, fast landslides would depend on the local slope steepness, geologic materials, and thickness of surficial deposits. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts of reservoir creation on large fast landslides. Until such time that these potential mitigation

Potential Environmental Effects of New Surface Water Supplies	
Resource	Discussion
	measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • There are no other ways in which construction or operation of new surface water storage reservoirs could result in a substantial degradation of water quality.
Land Use and Planning	• Construction and operation of new surface water storage facilities would not physically divide an established community because there are few communities in the vicinity of potential construction sites. Impacts would not occur. • Construction and operation of new surface water storage facilities would likely take place within areas designated as rural residential, open space or timber production zone (if on private lands) or on areas managed for forestry and wildlife (if on National Forest System lands or Bureau of Land Management administered lands). These lands are unlikely to be designated for dam and reservoir development and would require changes in zoning (for county or private lands) and changes in land use management designation (for National Forest System lands or Bureau of Land Management administered lands). • If the new surface water storage facilities were inconsistent with applicable land use plans, policies, or regulations, an amendment or variant from the local jurisdiction or National Forest or Bureau of Land Management approving the discretionary action associated with these facilities would be required to be obtained by the project proponent prior to project approval and construction. If no discretionary action occurred as a result of the construction or operation of the new surface water storage facilities, it is assumed they would not result in a conflict with local land use plans, policies, or regulations. Impacts would be less than significant. • Potential conflicts with habitat conservation plans, natural community conservation plans, Stanislaus or Sierra National Forest Plans or Bureau of Land Management plans or other plans, policies and regulations protecting biological species and resources are evaluated in the Biological Resources section of this table.
Mineral Resources	• Construction and operation of new surface water storage facilities would have a potential to result in the removal or inability to access state or locally designated mineral resource areas. This is because the new surface water storage facilities would inundate a large area along an existing river which could potentially include such designated mineral resource areas. If the new surface water storage facilities construction or inundation zone are located within a state or locally designated mineral resource area, construction and operation of these facilities would permanently remove access to these mineral resources. Before constructing new surface water facilities, sites would be assessed for suitability and property ownership as part of design and engineering feasibility studies. Sites would be assessed to determine if they are located on a state or locally designated mineral resource area, and mineral resource areas would be avoided to the extent feasible so that impacts on mineral resources can be avoided or minimized. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts associated with mineral resources during construction or reservoir operations. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, other than aggregate resources, there is limited potential to mitigate the loss of access to these mineral resources and impacts would be significant and unavoidable if they occurred.

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Resource	Discussion
Noise	• Construction of new surface water storage facilities could generate temporary noise or ground-borne vibrations if blasting is used. It is likely that the new surface water storage facilities would be constructed in areas relatively removed from towns or population centers with sensitive receptors (e.g., homes, hospitals, schools). Additionally, since this would be a major, multi-year construction effort public access to the area would be restricted, thereby limiting the potential for public exposure to construction noise. If sensitive receptors were adjacent to construction activities and experienced construction noise, the impacts would likely be temporary and would be required to follow existing local noise ordinances limiting the timing of construction (e.g., generally Mondays–Fridays, 7am–6pm). However, given the large scale of constructing a new surface water reservoir and the unique types of construction required, it is likely that activities may need to occur for extended periods of time in 24-hour intervals. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant noise impacts related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • New surface water storage facilities would generate minimal noise during operation. The noise would be from release of water from the dam, from hydroelectric components within the dam, or alarm bells. This noise would only occur within the immediate vicinity of the reservoir dam. It is anticipated there would be a very low probability that sensitive receptors (e.g., homes, hospitals, schools) would be located within close proximity to experience the operating noise generated because it is anticipated that the facilities would be not be located near an existing town or population center. People exposed to the noise would be those visiting or recreating in the immediate vicinity and noise associated with the facility would be an expected part of that experience. Impacts would be less than significant. • The construction and operation of new surface water storage facilities would not bring people within close proximity to an airport or expose people to airport noise. Impacts would not occur.
Population and Housing	• The construction and operation of new surface water storage facilities would not involve the construction of new homes in the area. However, some operational personnel would be necessary for dam and hydroelectric operation and development of recreation facilities on the reservoir are likely. Depending on the distance to local small towns, onsite housing might be required for operational personnel. Recreation could involve camping, hiking, swimming, non-motorized or motorized boating, jet skis, hunting and angling. Depending on the size of the reservoir there is potential that new local small businesses (such as marinas, house boats, tent camp grounds, camp grounds with recreational vehicle utility hook ups, grocery and general purpose stores) could be located onsite or nearby. These recreational and business amenities would be expected to draw seasonal recreational users. The construction and operation of new surface water storage facilities would not involve the construction of new homes, the extension of roads, or other infrastructure that may induce substantial property or population growth in an area. Accordingly, impacts would be less than significant. • The construction and operation of new surface water storage facilities would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the facilities would be located in relatively remote areas. Impacts would not occur.

Potential Environmental Effects of New Surface Water Supplies	
Resource	Discussion
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. The operation of new surface water storage facilities and associated recreation facilities would involve an increase in people in the area, primarily for seasonal recreational purposes. The increased recreational use in an area would require additional local fire protection, wild land fire protection (e.g., CALFIRE), police protection, electrical service, and water service. Electrical service would likely be provided by dam hydroelectric power and the local water supply would likely come from the new reservoir. The need for new schools is not considered likely given that any population growth, if it occurs, is expected to be small. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts on public services related to operations and recreational use. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Recreation	• If new surface water reservoirs were constructed and overlapped the portions of rivers designated as National Wild and Scenic River (83 miles of the Tuolumne River: 47 miles wild, 23 miles scenic, 13 miles recreational) or studied as potentially eligible (Stanislaus River) then the impacts would be significant and unavoidable. The impacts are considered significant and unavoidable because of the elimination of these designated recreational resources and there is no mitigation available that would reduce these recreation impacts to less than significant. • Construction of new surface water storage facilities would likely involve the development of reservoir-associated recreation facilities. Recreation could involve camping, hiking, swimming, non-motorized or motorized boating, jet skis, hunting, and angling. Depending on the size of the reservoir there is potential that new local small businesses (such as marinas, house boats, tent camp grounds, camp grounds with recreational vehicle utility hook ups, grocery and general purpose stores) could be located on site or nearby. These recreational and business amenities would be expected to draw recreational users and some permanent residents to the area. These new recreation opportunities would be a benefit to recreational use in the vicinity of the new surface water storage facilities. Potential impacts on other resources as a result of constructing new recreational facilities are addressed by resource in this table. • Construction and operation of new surface water storage facilities could increase the use of existing parks or recreational facilities in the local region as recreationists unfamiliar with the area explore the area. However, it is not anticipated that additional new recreational facilities would be constructed beyond those described for Population and Housing in this table (e.g., marinas, house boats, tent camp grounds). Impacts would not occur.

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Resource	Discussion
Transportation and Traffic	• Construction of new surface water storage facilities would result in substantial additional trips associated with pre-construction surveys (e.g., geotechnical, environmental), construction workers, and equipment delivery over a multi-year period. New surface water storage facilities likely would be located in rural, low population areas with a limited and narrow lane road network with limited baseline congestion. The increased traffic over this multi-year period would exceed local or regional road trip thresholds. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts on transportation and traffic related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction. • Operation of new surface water storage facilities and new recreational use of reservoir facilities would generate additional vehicle trips by workers and recreationists. The number of trips by dam workers would be small. However, recreation and recreation-associated traffic would likely be substantial at times (such as summer holiday weekends) potentially exceeding local or regional trip thresholds. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts on transportation and traffic associated with operations. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Construction of new surface water storage facilities would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Construction and operation of new surface water storage facilities would not be expected to exceed wastewater treatment requirements of the Central Valley Water Board because water releases from a new dam would be expected to meet water quality objectives in the receiving water. The additional storage could also provide flexibility to meet water quality objectives in the rim dams if there was additional control of inflowing water. Dam operational facilities and recreation sites would not be expected to require a new WWTP in the vicinity. Wastewater would be addressed via properly designed septic systems and/or closed vault toilet systems. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts from septic systems associated with construction and operations. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The construction and operation of new surface water storage facilities would require the construction of additional storm water drains for them or for the associated recreational facilities. However, surface water drainage design from these locations would be required to ensure that new septic system leach fields function properly. Table 16-38 lists potential mitigation measures that lead agencies (e.g., state or federal agencies, utility districts) can and should implement to reduce potentially significant impacts from septic systems associated with construction and operations (identified in the table under Utilities and Service Systems), and from storm water drains (identified in the table under Hydrology and Water

Potential Environmental Effects of New Surface Water Supplies

Resource	Discussion
	Quality). Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of new surface water storage facilities could generate solid waste from construction debris, from operational facilities and from recreation sites at the reservoir. Most of this type of solid waste is not considered hazardous. Disposal of hazardous and non-hazardous materials would follow all regulations and guidelines of solid waste in Class I (hazardous waste)/II landfills (non-hazardous waste landfills). Impacts would be less than significant.

16.3 Lower San Joaquin River Alternatives – Non-Flow Measures

This section describes non-flow measures that affected entities may undertake in the plan area between the rim dams on the Stanislaus, Tuolumne, and Merced Rivers or on the LSJR and in the southern Delta. Non-flow measures would not be implemented above the rim dams in the extended plan area. These non-flow measures would inform the body of scientific literature and understanding regarding special-status fish species and the stressors and mechanisms that have contributed to their decline on the three tributaries and in the southern Delta. The information provided by these measures could potentially be used to inform adaptive implementation decisions under each of the LSJR alternatives. The non-flow measures evaluated in this section include the following.

- Floodplain and Riparian Habitat Restoration
- Reduce Vegetation-Disturbing Activities in Floodplains and Floodways
- Gravel Augmentation
- Enhance In-Channel Complexity
- Improve Temperature Conditions
- Fish Passage Improvements—Fish Screens (screen unscreened diversions in tributaries and LSJR)
- Fish Passage Improvements—Physical Barriers in the Southern Delta
- Fish Passage Improvements—Removal or Modification to Human-Made Barriers to Fish Migration
- Predatory Fish Control
- Invasive Aquatic Vegetation Control (i.e., plant control)

While these actions may inform adaptive implementation, the State Water Board would not be undertaking these actions since these non-flow measures are beyond its regulatory authority to undertake; rather, it is the entities affected by the LSJR alternatives, or resource agencies with the authority to do so, who could choose to undertake one or more of these actions to inform adaptive implementation. The environmental impacts of these potential actions are evaluated below.

16.3.1 Floodplain and Riparian Habitat Restoration

Floodplain and riparian habitat restoration is recognized as a key component of comprehensive ecosystem restoration and species recovery efforts in the Central Valley. These types of projects are typically focused on the lowland mainstem and tributary reaches of Central Valley rivers, such as the Stanislaus, Tuolumne, and Merced Rivers, where channels, bars, and floodplains are formed and maintained through the processes of sediment transport, deposition, and channel migration. In addition to flow modification to promote natural physical and ecological processes that form and sustain riparian and floodplain habitat (Opperman 2012), a number of non-flow actions, typically acting in concert with flow, have been identified as integral components of floodplain and riparian habitat restoration. It is broadly recognized that historical and contemporary impacts on floodplain and riparian habitat associated with flow regulation, channelization, levee building, and human land use have greatly diminished the capacity of Central Valley rivers to support the ecologic functions necessary to restore native fish and wildlife populations (CALFED 2000a, USFWS 2001), and that active, physical modification of existing and historical river corridors is also required to substantially improve these functions (McBain and Trush 2000).

Typical non-flow measures to restore floodplain and riparian habitats include the following:

- Creation or expansion of natural or engineered floodways or flood bypasses.
- Modifications of river and floodplain geometry (e.g., floodplain lowering) to increase floodplain inundation.
- Active planting or allowing natural establishment of riparian vegetation on restored floodplain surfaces or converted agricultural land.
- Hydrologic reconnection of historical floodplains to active river channels through levee breaches and/or setbacks.
- Removal of riprap or other bank protection (e.g., dredger tailings) restricting active channel migration and floodplain creation.

Cost Evaluation

Floodplain and riparian habitat restoration can be achieved through the different approaches described above. While site-specific conditions influence the cost of the approach, in general, removal of riprap or other bank protection and active plantings are generally lower cost approaches when compared to creating or expanding natural or engineered floodways, modifications of river and floodplain geometry, or hydrologic reconnection of historical floodplains through levee breaches and/or setbacks. This is generally because removal of riprap and active plantings may require fewer feasibility and design studies, fewer permits, and fewer responsible agencies may be involved and require limited adaptive management and mitigation monitoring plans to evaluate the effectiveness of the projects. In addition, removal of riprap and active plantings are less likely to require the purchase of property, which can be a substantial cost associated with floodplain and riparian habitat restoration. For example, the LSJR Floodplain Protection and Restoration Project acquired a total of 223.54 acres of wildlife habitat adjacent to the SJR and eastside tributaries for preservation and future enhancement of riparian and wetland habitats for a cost of $1.1 million (CALFED ERP 2016). The Basso Bridge Ecological Reserve and Merced River Ranch Land Acquisitions on the Merced River were purchased for approximately $830,000 of riparian habitat in 1997 to protect spawning riffles and enhance riparian species (CALFED ERP 2016). At the time of purchase, it was simply to secure the land and active restoration was not planned (CALFED ERP 2016). Levee breaches depending on the size, scale, and location of the projects, can be very costly. For example, the Cosumnes River Floodplain Restoration Project, where the U.S. Army Corps of Engineers breached and abandoned 5.5 miles of levees to allow the river to flow into the floodplain as a result of the 1997 floods, resulted in a cost of $1.55 million (Swenson et al. n.d.).

Environmental Evaluation

The primary sources of information for the following general description of floodplain and riparian restoration projects and associated environmental impacts were DWR (2013a), National Marine

Fisheries Service (NMFS) (2013), U.S. Fish and Wildlife Service (USFWS) (2013), and McBain and Trush (2000). Additional references are cited below.

Summary of Potential Action

Planning and design activities for floodplain and riparian restoration projects may include topographic surveys, flood frequency analysis, hydraulic modeling, geomorphic investigations, and sediment modeling of alternative design scenarios. Integration of ecological criteria to define specific hydrologic, hydraulic, and topographic attributes of functional floodplain and riparian habitat may also be used to guide restoration design and optimize benefits for target restoration species (Williams et al. 2009, Matella and Merenlender 2014).

The magnitude of construction impacts on vegetation, soils, streambed substrates, and water quality depends on the extent and duration of disturbance to existing habitat and species, and the extent of temporary and permanent habitat loss. Construction activities for floodplain and riparian restoration projects may include demolition and/or relocation of roads, utilities, and other existing structures; clearing and grubbing of staging and work areas; removal and/or placement of rock or biotechnical slope protection (depending on hydraulic considerations); grading of river–floodplain connections and floodplain surfaces; stockpiling of equipment and materials; and installation of irrigation systems and restoration plantings. Typical construction equipment includes graders, excavators, loaders, cranes, and barges. Common environmental commitments or BMPs to avoid, minimize, or offset potential environmental effects may include seasonal work windows; preconstruction biological surveys; biological monitoring during construction; invasive species prevention; construction noise and light reduction measures; traffic control; SWPPP; spill prevention, control, and countermeasure plan; turbidity compliance monitoring; and soil hazard testing and disposal.

Operation and maintenance of floodplain and riparian restoration sites may include vegetation maintenance (irrigation, weeding, and monitoring), control of burrowing rodents, road reconditioning, visual inspections, and slope repair. To address uncertainties in the ecological processes governing floodplain and riparian habitat formation and maintenance at selected sites, progress toward achieving the objectives or optimizing the benefits of these projects is typically monitored and guided through an adaptive management process.

Potential Environmental Effects

Depending on the size and scale of floodplain or riparian restoration, these types of projects may fit within a categorical exemption under CEQA. CEQA allows categorical exemptions for classes of projects which have been determined not to have a significant effect on the environment. (Pub. Res. Code, § 21084.) Specifically, small habitat restoration projects, on sites that do not exceed 5 acres, are exempt from CEQA review under a Class 33 categorical exemption provided that:

- There would be no significant adverse effect on endangered, rare, or threatened species or their habitat.
- There are no hazardous materials or toxic waste at or around the project site that may be disturbed or removed.
- The project would not result in impacts that are significant when viewed in connection with effects of past projects, the effects of current projects, and the effects of probable future projects.

Small habitat restoration projects include stream or river bank revegetation to improve habitat for amphibians or native fish.

If a floodplain or riparian habitat restoration project does not meet the Class 33 exemption requirements, then the project would require CEQA review. Construction of floodplain and riparian habitat restoration projects may result in temporary and localized effects typically associated with construction activities, including a change in water quality, air quality effects, and ground and channel disturbance. Floodplain and riparian restoration would likely occur below the dams which are accessible to Chinook salmon and steelhead on the LSJR, and Stanislaus, Tuolumne, and Merced Rivers where there is currently a lack of floodplain and riparian habitats. The restoration areas would vary by river, depending on the channel geometry and if fish are currently using the areas. River channels would be graded and riparian vegetation planted in areas that could support special-status fish species such as Chinook salmon and steelhead. Aquatic and terrestrial biological resources would be the most affected during construction activities to restore floodplain and riparian habitat.

It is reasonable to assume that restoration of floodplain and riparian habitat would be professionally installed by contractors familiar with such projects. Depending on the magnitude of the projects, construction could last anywhere from several weeks to several months. If the project is large enough, it may extend over two construction seasons but last no more than a total of 12 months, to comply with June–October in-water work restrictions. It is expected construction activities would occur during the dry season (typically June–October) when anadromous fish would not be spawning and in compliance with endangered species requirements. BMPs for controlling sediment and contaminant release into waterbodies would be used to minimize potential effects associated with water quality and hazardous materials per regulations under the Clean Water Act and any permitting requirements and conditions from the Central Valley Water Board or the U.S. Army Corps of Engineers. Floodplain restoration sites would result in changes to hydraulics, channel substrate, and stream habitats. Riparian restoration would increase habitat for special-status wildlife and fish species. The changes to hydraulics, channel substrate, stream habitats, and increases in habitat conditions are expected to achieve the purpose of restoring the habitat and benefit aquatic and terrestrial biological resources.

Table 16-12, *Potential Environmental Effects of Floodplain and Riparian Habitat Restoration*, summarizes the potential environmental effects associated with floodplain and riparian habitat restoration. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this non-flow measure and is referenced in Table 16-12 where appropriate.

Table 16-12. Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration	
Resource	Discussion
Aesthetics	• Construction and operation of floodplain and riparian restoration projects could affect scenic vistas, but only temporarily during construction and they would not permanently alter scenic vistas. Construction may be observable for a temporary period of time when heavy equipment is used to grade banks, move sediment, and plant vegetation around the project site. However, it is anticipated that the location of these projects would not be within close proximity to sensitive viewers (e.g., recreationists or residents) given the remote location of the projects within rivers. If sensitive viewers are located within close proximity, the temporary nature of construction and the fact that views would not be permanently changed would be such that significant impacts would not occur. Operation may be noticeable at first during the time it takes for natural processes such as establishment of riparian vegetation and river channel dynamics to occur. After that, the river channel may be more aesthetically pleasing due to the enhanced vegetation and restoration of natural river morphology. Lighting is not expected to be used during floodplain and riparian restoration projects. Construction is expected to occur during daylight hours given the location of the projects. Impacts would be less than significant.
Agriculture and Forestry Resources	• Construction and operation of floodplain and riparian restoration projects could be located on lands used for agriculture if the expansion of floodplain habitat included setback levees and breaches. Land use below the dams on the rivers is predominantly zoned as general agriculture and limited agriculture. Allowed uses for general agriculture typically include compatible public, quasi-public, and special uses and natural open space areas. Limited agriculture also allows for compatible public, quasi-public, a special uses such as parks and natural open spaces. Floodplain expansion and riparian vegetation planting or natural establishment may occur on agricultural land (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) if located close to the river channel. In some instances, if agricultural land is allowed for special uses and natural open spaces, floodplain expansion and riparian vegetation restoration could fall into these categories and there would be no conflict with existing zoning for agriculture use or a Williamson Act contract. If agricultural land is not allowed for special uses and natural open space, then floodplain expansion and riparian vegetation may permanently convert Prime Farmland, Farmland of Statewide Importance and Unique Farmland to nonagricultural uses (i.e., restored floodplain and riparian habitat). The extent of the impact would depend on the total acres permanently removed from agricultural use and whether they were in Williamson Act contracts. Agricultural mitigation programs and agricultural preservation statutes are designed to compensate for the premature and unnecessary conversion of agricultural land to urban uses, discourage discontiguous urban development patterns, and promote the conservation, preservation, and continued existence of open space lands. For this reason, traditional agricultural mitigation programs, such as agricultural conservation easements, may be inapplicable to habitat projects, which retain land in open space use even if it is not agricultural. As a result, agencies have taken different approaches in addressing conversion of agricultural lands for ecosystem improvements, based, in part, on their missions. Table 16-39 identifies mitigation strategies that may be applicable that lead agencies can and should implement, which have been identified for prior habitat

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration	
Resource	Discussion
	projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Forest land is limited or does not occur below the dams on the rivers; therefore there would be no conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Construction of floodplain and riparian restoration projects would likely result in emissions associated with construction equipment and construction worker vehicle trips. The quantity, duration, and the intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. Floodplain and riparian restoration could take several weeks to several months, depending on the magnitude of the project. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since construction of groundwater wells does not require lengthy construction activities, the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the SJVAPCD regulations and established thresholds. Lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction of floodplain and riparian restoration projects would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction of floodplain and riparian restoration projects would not result in growth because these projects are habitat restoration projects for the benefit of special-status fish species. Accordingly, these projects would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • Operation of floodplain and riparian restoration projects would likely result in scheduled maintenance or monitoring vehicular trips. Emissions from the vehicles would not prevent compliance with regulations or exceed thresholds established by SJVAPCD, conflict with or obstruct implementation of the applicable air quality plan or violate any air quality standard or contribute substantially to an existing or projected air quality violation, or result

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration	
Resource	Discussion
	in a net increase of any criteria pollutant for which the project region is nonattainment under applicable federal or state ambient air quality standards, given the limited number of vehicles over a longer timeframe. Impacts would be less than significant. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). Floodplain and riparian restoration projects would not create objectionable odors affecting a substantial number of people. Impacts would not occur.
Biological Resources	• Construction of floodplain and riparian restoration projects could release sediment and possibly hazardous materials (e.g., oil or gas from construction equipment) into waterbodies, affecting water quality. Release of sediment can bury macroinvertebrates which are prey for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat. Operation of floodplain and riparian restoration projects would change aquatic habitat by changing river width, river habitat types (riffles, pools, runs), and hydraulics. While construction may have some temporary adverse effects, overall restoration would have beneficial long-term effects for sensitive aquatic and terrestrial species (e.g., Chinook salmon, steelhead, California red-legged frog, western yellow-billed cuckoo). Water quality measures such as monitoring turbidity during construction to ensure compliance with the objectives of the Water Quality Control Plan for the Sacramento River and SJR Basins (Basin Plan) and construction BMPs would be implemented as either mitigation measures under CEQA or permit requirements and conditions. Furthermore, a mitigation, monitoring, and management plan (MMP) would be enforced after restoration is completed. These measures are part of permitting requirements and conditions by resource agencies including USFWS, California Department of Fish and Wildlife (CDFW), Central Valley Water Board, and U.S. Army Corps of Engineers. The floodplain and riparian restored areas would need maintenance to control invasive plant species, and monitoring to determine survival of planted riparian vegetation and to ensure the floodplain is functioning as designed and benefiting fish and wildlife species once construction is complete. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction of floodplain and riparian restoration projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction of floodplain and riparian restoration projects would not interfere with the movement of native residential or migratory fish species and associated migratory corridors, or impede the use of nursery sites because any work done in the water would occur during June to October when fish are not spawning or migrating. In addition, overall it is expected that there would be a beneficial effect on special-status fish species following restoration. Impacts would not occur.

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
	• The surrounding habitat on river banks may include riparian vegetation and/or wetlands. Riparian vegetation may have to be removed to facilitate heavy equipment movement and wetlands may also be disturbed during construction activities. This would result in a significant impact on riparian habitat and wetlands. Under operations, wetlands would not be affected and riparian vegetation would be enhanced. Removal and/or disturbance of riparian and wetlands habitats would be compensated for at a ratio appropriate for the disturbance per standard permit requirements or conditions from the U.S. Army Corps of Engineers and the Central Valley Water Board, or the floodplain and riparian restoration would be self-mitigating if it included wetland habitat. This would reduce and minimize impacts on fish and wildlife species and their habitats. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction of floodplain and riparian restoration projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of floodplain and riparian restoration projects would be located in river reaches that support special-status fish species such as Chinook salmon and steelhead. These areas are expected to have high potential for special-status plant species, animal species, and habitat, and support biological resources. Floodplain and riparian restoration projects would occur during the least sensitive periods of special-status species life stages, (i.e., during the dry season between June and October), as this would reduce and minimize impacts on aquatic species and would be required through either the CEQA process or through permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce potentially significant environmental effects of construction and operations on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • While construction may result in temporary localized adverse effects on special-status species, plants, and habitat, construction activities are highly unlikely to result in population level adverse effects for any species. Floodplain and riparian restoration are discussed under the SJR Wildlife Refuge CCP and the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (SJMSCP) as a means to enhance fish habitat on the rivers. In addition, conflicts with local policies as a result of construction are not considered significant because of the temporary and localized nature of the effects. As such, this impact would be less than significant.

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
Cultural Resources	• Construction and operation of floodplain and riparian restoration projects would be within existing river banks and channels or immediately adjacent. It is unknown if cultural resources (significant historical, archeological, or paleontological resources) exist in these locations, and river banks that contain cultural resources could be excavated for floodplain restoration during construction. Typically the river channels have had high levels of disturbance because of hydraulic conditions; and as such, there is a low potential for significant cultural resources to exist within the rivers. Similarly, there would be a low potential for the discovery of human remains due to the regular disturbance. However, if levees were breached during construction, there could be cultural resources or human remains within the potential levee. Operation of floodplain and riparian restoration areas would have a very low potential to affect cultural resources because operation would be along the river bank and channels. Where construction within areas that may contain cultural resources cannot be avoided, an assessment would be conducted of the potential for damage to cultural resources prior to construction. The assessment may require hiring a qualified cultural resources specialist to determine the presence of significant cultural resources or human remains. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant effects on cultural resources associated with construction of floodplain and riparian restoration projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.
Geology and Soils	• Floodplain and riparian restoration could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, floodplain and riparian restoration would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, or landslides. Impacts would not occur. • Project sites would be evaluated before construction begins for the potential of soil erosion in the design of the restoration project. Floodplain and riparian restoration projects should not result in substantial erosion or sedimentation that would not support the objectives of the restoration under operating conditions. However, given construction would likely take place along rivers and in riparian areas where erosion can take place depending on the soil characteristics, geology, and area of disturbance, lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant erosion or sediment effects associated with construction or operation of floodplain and riparian restoration projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Floodplain and riparian restoration would not bring people to the risk of earthquakes or geologic hazards, meaning the operation of the restored areas would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur.

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
Greenhouse Gas Emissions	• Construction of floodplain and riparian restoration would result in increased GHG emissions from use of heavy equipment. While construction activities would be limited from several weeks to several months, it is likely that restoration activities could result in a potentially significant GHG impact. Although the SJVAPCD has not established construction-related GHG thresholds, they have identified a level of GHG emissions per year (230 MT CO$_2$e) below which project-specific increases in GHG emissions would be considered equivalent to zero for CEQA purposes. This amount, known as a ZEL, can be used to evaluate construction emissions when they are amortized over the project's anticipated operational lifespan. For example, a project using a 30-year operational lifespan would be considered significant if total construction emissions would exceed 6,900 MT CO$_2$e (230 MT CO$_2$e/year* 30 years = 6,900 MT CO$_2$e), while a project using a 50-year operational lifespan would be considered significant if total construction emissions would exceed 11,500 MT CO$_2$e (230 MT CO$_2$e/year * 50 years = 11,500 MT CO$_2$e). Depending on the level of construction activities and the potential operational lifespan of the project, construction-related GHG emissions could exceed these values and result in a potentially significant impact. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • During operation, some vehicles may be needed for monitoring or maintenance of restored areas. However, the trips would be limited, of very short duration, and over a long period of time (e.g., one trip every year). As such, they would likely result in extremely small quantities of GHG emissions. However, GHG emissions may still exceed SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
	inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Construction and operation of floodplain and riparian restoration would not be a hazard or provide a safety concern to public or public use airports or private airstrips because restoration would be constructed and operated within, or immediately adjacent to, the river banks and channels and would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, construction and operation of floodplain and riparian restoration would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Construction and operation of floodplain and riparian restoration would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road and within, or immediately adjacent to, the river banks and channels. Impacts would not occur. • Construction and operation of floodplain and riparian restoration projects would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • Construction of floodplain and riparian restoration projects could involve the temporary use of small amounts of hazardous materials, such as gasoline or diesel, to power construction equipment. Excavation would be necessary and utility lines could be within proximity to the project site. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due to hazards and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The precise location of where floodplain and riparian restoration projects would be constructed is not yet known; however, these projects could be constructed within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation activities. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
	hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962. These sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the DTSC for Calaveras, Tuolumne, or Mariposa Counties (CalEPA 2016). There were a total of 17 sites identified for Merced, San Joaquin, and Stanislaus Counties. In addition to these sites identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 500 leaking underground storage tanks designated as open in these counties (CalEPA 2016). There are approximately 55 facilities in these counties that have received CDOs/CAOs not identified as non-hazardous wastes, domestic wastewater or domestic sewage (CalEPA 2016). The active and open leaking underground storage tank cases and the CDO/CAO facilities are located throughout these counties. Although it is not yet known precisely where floodplain and riparian restoration would be constructed, if restoration were done on a Cortese Site, because construction activities would likely entail some ground disturbance (e.g., grading), there would be potential for release of existing soil contaminants. Were this to occur, impacts could be significant. Table 16-39 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • Construction of floodplain and riparian restoration sites would require excavation. Utilities may be underneath the sites or adjacent to a site and may need to be relocated or avoided. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potential hazards associated with excavation around utilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.
Hydrology and Water Quality	• Construction of floodplain and riparian restoration projects may temporarily change water quality due to grading the river banks and channels. Excavating the river bank and driving heavy equipment in and near the river channel could result in a temporary increase in turbidity. Due to the limited nature of construction and construction activities limited to the dry season, it is not expected that water quality standards for the protection of fish and wildlife would be exceeded because construction timing (i.e., June–October) would avoid the most sensitive life stages of special-status fish species. Additionally, turbidity would be monitored to maintain compliance with Basin Plan water quality objectives. Construction of floodplain and riparian restoration projects would not alter the capacity of existing or planned storm water drainage systems, and would not provide substantial additional sources

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
	of polluted runoff. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of floodplain and riparian restoration projects would not substantially deplete groundwater supplies or interfere substantially with groundwater recharge because these projects would not require groundwater during construction or operation, and would not result in an increase in impervious surfaces. Impacts would not occur. • Operation of floodplain and riparian restoration projects could alter the existing drainage pattern of the site or area, but is not expected to cause substantial erosion, siltation, substantial runoff, or result in flooding on- or offsite. Floodplain restoration is typically used as a mechanism to decrease flooding. Floodplains allow water to spread across a wider area and relieve constricted channels of flow. Constriction of flow typically results in erosion or siltation. Additionally, site design would assess existing hydrology and channel geomorphology to ensure the restoration of floodplain or riparian habitat meets project objectives and provides benefits to intended targeted species. An MMP, which is part of the permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers, would be implemented to ensure no erosion is occurring, floodplain design is successful, and newly planted riparian vegetation is surviving. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of floodplain and riparian restoration projects would not place housing within a 100-year flood hazard area because implementation of these restoration project would not entail the construction of housing. Impacts would not occur. • Construction and operation of floodplain and riparian restoration projects would not substantially increase the number of people exposed to the risk of flooding because these projects would not draw people to flood hazard locations. As such, construction and operation of floodplain and riparian restoration projects would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Construction and operation of floodplain and riparian restoration projects would not entail the construction of structures in a 100-year flood hazard area that would impede or redirect flows. Impacts would not occur. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Floodplain and riparian restoration is not expected to occur near a lake or reservoir. Impacts would not occur.

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
	• There are no other ways in which construction or operation of floodplain and riparian restoration areas could result in a substantial degradation of water quality.
Land Use and Planning	• Construction and operation of floodplain and riparian restoration projects would not physically divide an established community because they would be located within existing river banks and channels, or immediately adjacent to them, and communities are not established in these areas. Impacts would not occur. • Construction and operation of floodplain and riparian restoration sites would occur in existing river banks and channels, or immediately adjacent to them, and would not conflict with land use designations or zoning. Frequently these areas are designated natural resource or open space areas by land use plans. Restoration would be consistent with those designations because it would enhance existing habitat for fish and wildlife species. Impacts would not occur. • The following habitat conservation plans cover parts of the Stanislaus, Tuolumne, and Merced Rivers: SJR Wildlife Refuge CCP and the SJMSCP. These plans protect special-status species within the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers. As described in the Biological Resources section of this table, there would be some temporary construction impacts on adjacent riparian and/or wetland areas, but lead agencies would mitigate these temporary impacts through measures identified in Table 16-39. As such, no conflicts are expected with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations. Impacts would not occur.
Mineral Resources	• There are known aggregate mines along all three eastside tributaries[15] (Clinkenbeard 1999, Clinkenbeard 2012a and 2012b, Higgins and Dupras 1993, Rapp et al. 1977, Smith and Clinkenbeard 2012). Although these may not all be active at present, it is assumed some exist on each river even if their exact location with respect to active channel proximity is unknown. Construction and operation of floodplain and riparian restoration could have the potential to result in the removal or inability to access state or locally designated mineral resource areas, depending on the location of the restoration area and the location of the active mining site. However, there are several reasons why there is a low potential for this to occur. Before constructing floodplain and riparian restoration areas, sites would be assessed for suitability and property ownership as part of design and engineering feasibility studies. Restoration sites would be assessed to determine if they are located on a state or locally designated mineral resource area. It is likely these areas would be avoided for restoration because these areas do not have the characteristics needed for successful floodplain and riparian habitat restoration projects (i.e., suitable substrate and lack of aggregate). Further, it is unlikely that a gravel operator/owner would allow floodplain and riparian restoration on a designated mineral resource area that is being actively mined. In addition, aggregate mine operators are required to reclaim mined areas once the mining is complete and there may be opportunities to enter into cooperative agreements for floodplain and riparian habitat restoration projects once active mining is complete. Therefore, there is a low

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[15] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
	potential that the construction and operation of floodplain and riparian restoration would remove or prevent access to state or locally designated mineral resource areas. As such, impacts would be less than significant.
Noise	• Construction of the floodplain and riparian restoration sites would create noise related to the use of heavy construction equipment. The sites would be located within, or immediately adjacent to, river banks and channels on the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers where people generally do not live. It is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies due to the remote location of these projects from populous areas. Excessive ground-borne vibration or ground-borne noise levels are also not expected due to the location of the projects and the standard type of construction equipment that would be used. Temporary elevated noise in excess of standards established in local general plans, noise ordinance, or applicable standards, may occur during the day (as construction is not expected to occur at night) and for short periods of time. However, given the limited exposure of potential sensitive receptors to this potential temporary increase and low likelihood of potential sensitive receptors to exist because of the remoteness of the project sites, it is expected impacts would be less than significant. Operation of the floodplain and riparian restoration sites would not create noise. There may be some maintenance activities requiring construction equipment and vehicular trips for monitoring, but they would not create a permanent increase in ambient noise and would be temporary in duration and infrequent. This impact would be less than significant. • Construction and operation of floodplain and riparian restoration sites would not generate excessive noise that would result in people's exposure to excessive noise levels near airports. Impacts would not occur.
Population and Housing	• The construction and operation of floodplain and riparian restoration sites would not involve construction of new homes or businesses, extension of roads, or other actions that may induce substantial property or population growth in an area. Furthermore, restoration sites would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • The construction and operation of floodplain and riparian restoration sites would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere. Restoration sites would be located within, or immediately adjacent to, river banks and channels. No homes or people would be displaced. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, construction and operation of floodplain and riparian restoration sites would not involve an increase in population or housing. In addition, these actions would not include proposals for new housing or increase demands for school services or facilities. Impacts would not occur.

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
Recreation	• Construction of floodplain and riparian restoration sites would occur within, or immediately adjacent to, river banks and channels on the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers. It is possible that recreational facilities would be located in areas where floodplain and riparian restoration sites would occur. If recreational facilities were located within very close proximity, construction of floodplain and riparian restoration sites may affect them; however, it is unlikely that there would be significant effects on recreational facilities because construction would be temporary and limited (e.g., several weeks to several months). Construction and operation of floodplain and riparian restoration sites would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would be less than significant.
Transportation and Traffic	• Construction of floodplain and riparian restoration sites could result in some additional vehicle trips associated with construction workers. The temporary increased traffic during construction would likely not exceed local or regional road trip thresholds, because generally a small number of construction workers are required. Generally these types of projects require approximately 45 additional trips per day for construction workers and approximately 50 trips per day for borrow material transport (CVFPB 2013). Additionally, the duration of construction would be short (e.g., several weeks to several months). Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant transportation and traffic impacts related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Operation of floodplain and riparian restoration sites would not generate additional trips beyond those required to maintain the sites. If maintenance activities are needed, they would be temporary in nature, infrequent and operation of the sites would not increase traffic. Impacts would not occur. • Construction of floodplain and riparian restoration sites would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.

Potential Environmental Effects of Floodplain and Riparian Habitat Restoration

Resource	Discussion
Utilities and Service Systems	• Construction and operation of floodplain and riparian restoration sites would not affect the ability to meet wastewater treatment and discharge requirements of the Central Valley Water Board because site restoration would not involve wastewater. Impacts would not occur. • Construction and operation of floodplain and riparian restoration sites would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. As such, impacts would not occur. • Construction and operation of floodplain and riparian restoration sites would not need the construction of additional storm water drains because the restoration would be built within, or immediately adjacent to, river channels and would not generate storm water and would not need storm water infrastructure. Impacts would not occur. • Construction and operation of floodplain and riparian restoration sites would not generate an increase in solid waste because modifications would be limited to the river bank and channel and would not generate large quantities of solid waste. Impacts would not occur. • Construction and operation of floodplain and riparian restoration sites would not require a water supply because modifications to the river bank and channel do not require a water supply. Impacts would not occur.

16.3.2 Reduce Vegetation-Disturbing Activities in Floodplains and Floodways

This action may be included as part of discretionary or non-discretionary permit conditions, guidelines, or policies governing existing levee and floodway maintenance activities as well as implementation of floodplain, floodway, or riparian management and restoration plans in areas adjacent or within the Stanislaus, Tuolumne, and Merced River channels. Participating entities may include NMFS, CDFW, USFWS, Central Valley Water Board, Central Valley Flood Protection Board, U.S. Army Corps of Engineers, local landowners, county governments, local agricultural commissions, and other land management agencies in the watersheds of the LSJR, Stanislaus, Tuolumne, and Merced Rivers. Where such actions do not conflict with existing federal, state, or local flood risk reduction policies, regulations, or ordinances, reducing vegetation-disturbing activities would apply to grazing, mowing, cutting, spraying, disking, and other activities to promote preservation and restoration of riparian vegetation in floodplains or floodways.

Cost Evaluation

Removal of floodway vegetation is typically considered a maintenance cost by the responsible flood control agencies. Reduction in floodway vegetation removal could be accomplished as a collaborative effort between the flood control and environmental agencies. The flood control agency maintenance costs would be reduced by allowing vegetation to stay in the floodway. If environmental agencies incentivized retaining vegetation, then flood control agencies could receive a credit for increasing habitat.

Environmental Evaluation

Measures to reduce vegetation-disturbing activities in floodplains and floodways include but are not limited to the following:

- Develop grazing strategies that protect and improve streamside vegetation and minimize bank disturbance.
- Conduct outreach to inform landowners of state and federal laws and regulations that protect riparian, wetland, and Endangered Species Act (state and federal) protected vegetation.
- Review and potentially modify existing floodplain, floodway, and riparian vegetation management plans, or develop new ones using the best available science, to balance the needs of the ecosystem, public safety, and other considerations.
- Compile data, conduct studies, and review literature to determine the influence that large trees and other vegetation types have on levee and floodway safety, and use this information to make science-based floodplain and floodway management decisions.

Potential Environmental Effects

The measures listed above that would reduce vegetation-disturbing activities have a relatively limited ability to result in significant physical impacts on the environment. These measures would generally not require substantial construction activities, and would not result in potential construction-related environmental impacts.

CEQA allows categorical exemptions for classes of projects which have been determined not to have a significant effect on the environment. (Pub. Res. Code, § 21084.) Specifically, information collection is exempt from CEQA review under a Class 6 categorical exemption. The Class 6 exemption consists of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource. These may be strictly for information gathering purposes or as part of a study leading to an action which a public agency has not yet approved, adopted or funded. (Pub. Res. Code, § 21084.) In addition, a Class 7 categorical exemption consists of actions taken by regulatory agencies to assume the maintenance, restoration, or enhancement of natural resources where the regulatory process involves procedures for protection of the environment. (Pub. Res. Code, § 21084.) Examples include, but are not limited to, wildlife preservation activities by CDFW. Since the measures to reduce vegetation-disturbing activities in floodplains and floodways generally do not require construction activities, some of the measures may be categorically exempt from CEQA including: conducting outreach to land owners, compiling data, and reviewing literature for reducing vegetation-disturbing activities.

Reviewing and modifying management plans could physically affect the environment if the modifications are implemented. If modification to these plans resulted in more floodplain restoration projects and riparian habitat restoration projects, then impacts would be similar to those disclosed in Section 16.3.1, *Floodplain and Riparian Habitat Restoration*, and in Table 16-12, *Potential Environmental Effects of Floodplain and Riparian Habitat Restoration*. Developing strategies to protect and improve streamside vegetation could result in actions such as fencing off certain areas to prevent or reduce grazing or other more intensive ground-disturbing agricultural activities or reducing streamside application of herbicides and pesticides. These types of physical actions taken to reduce vegetation disturbance would be considered minor, and are not expected to result in significant environmental impacts on resources, including special-status species, given the limited geographic scope and scale when compared to areas that would not be affected by the actions.

Reducing vegetation-disturbing activities in floodplains and floodways may result in long-term beneficial effects on water quality, hydrology, and channel geometry because vegetation stabilizes slopes and retains sediment resulting in clearer water, creates more complex habitat for fish by changing water velocity, and can narrow or widen the river channel. The reduction of vegetation-disturbance activities would likely occur below the major rim dams on the LSJR, and the Stanislaus, Tuolumne, and Merced Rivers where there is a lack of riparian habitat or there is active vegetation disturbance. A change in vegetation could result in changes to hydraulics, channel substrate, and stream habitats. Controlling erosion and allowing riparian vegetation to become re-established by fencing off streams from cattle, would improve water quality and habitat for special-status wildlife and fish species. These changes are expected to benefit aquatic and terrestrial biological resources.

Table 16-13, *Potential Environmental Effects of Reducing Vegetation-Disturbing Activities in Floodplains and Floodways*, summarizes the potential environmental effects associated with reducing vegetation-disturbing activities in floodplains and floodways. Those impacts associated with floodplain or habitat restoration are identified in Table 16-12, *Potential Environmental Effects of Floodplain and Riparian Habitat Restoration,* and are not incorporated into Table 16-13.

Table 16-13. Potential Environmental Effects of Reducing Vegetation-Disturbing Activities in Floodplains and Floodways

Potential Environmental Effects of Reducing Vegetation-Disturbing Activities in Floodplains and Floodways	
Resource	Discussion
Aesthetics	• Studies or activities implemented to reduce vegetation-disturbing activities would not affect or change scenic vistas. No lighting would be used during the activities, all would be done during daylight hours. Impacts would not occur.
Agriculture and Forestry Resources	• Reduction of vegetation-disturbing activities could be located on lands used for agriculture or forestry, depending on how far reducing vegetation-disturbing activities extend from the Stanislaus, Tuolumne, and Merced Rivers and the extent of implementation of the vegetation-disturbing reduction activities. While these measures may decrease the level of agricultural activities or grazing occurring adjacent to a river, they are not expected to result in a conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use. Furthermore, it would be expected that modifications to management plans and strategies would assess conflicts with existing zoning for agriculture use or a Williamson Act contract, or conflict with existing zoning of forest land in order to balance the needs of the ecosystem and the needs of public safety and other land use considerations. Impacts would not occur.
Air Quality	• Air quality would not be affected by reducing vegetation-disturbing activities because no heavy construction equipment would be used. Emissions from the vehicles used for implementation and monitoring of the measures identified to reduce vegetation-disturbing activities would not prevent compliance with regulations or exceed thresholds established by SJVAPCD, conflict with or obstruct implementation of the applicable air quality plan or violate any air quality standard or contribute substantially to an existing or projected air quality violation, result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standards, or create objectionable odors. Impacts would not occur.
Biological Resources	• Reduction of vegetation-disturbing activities would not: (1) have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations; (2) adversely affect riparian habitat or federally protected wetlands; (3) interfere with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites; or (4) conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance. This is mainly because reduction of vegetation-disturbing activities would not require substantial construction activities, the use of heavy construction equipment, or removal of habitat. These reduction of vegetation-disturbing activities are expected to have a beneficial effect on fish and wildlife species habitat. Additionally these activity-reduction measures would not conflict with the provisions of the SJR Wildlife Refuge CCP and the SJMSCP, which covers the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers. Impacts would not occur.
Cultural Resources	• Reduction of vegetation-disturbing activities would not cause a substantial adverse change in the significance of cultural resources (significant historical, archaeological, or paleontological resources), directly or indirectly destroy a unique paleontological resource or site or unique geologic feature, or disturb any human remains because substantial ground-disturbing activities are not expected as a result of implementing the reduction measures. Impacts would not occur.

Potential Environmental Effects of Reducing Vegetation-Disturbing Activities in Floodplains and Floodways

Resource	Discussion
Geology and Soils	• Reduction of vegetation-disturbing activities would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. The activities would not increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Reducing vegetation-disturbing activities would actually prevent erosion and sediment release because less activities would occur adjacent to the river channels. Impacts would not occur.
Greenhouse Gas Emissions	• Reduction of vegetation-disturbing activities would not result in increased GHG emission because no heavy construction equipment would be used. Activities may require vehicle trips to perform any studies required, but these would be trips of very short duration over a long period of time and would have less-than-significant impacts from GHG emissions, as potential GHG emissions could be reduced as vegetation- disturbing activities are reduced. Impacts would be less than significant.
Hazards and Hazardous Materials	• Reduction of vegetation-disturbing activities does not require the use or transportation of hazardous materials. Therefore, reduction of vegetation-disturbing activities would not be expected to create a significant hazard to the public or the environment through release of these types of substances, or result in a hazard to schools if these activities occur within one-quarter mile of a school or schools. Impacts would not occur. • Reduction of vegetation-disturbing activities would not be a hazard or provide a safety concern to public or public use airports or private airstrips because they would not result in the construction of tall structures and would be located either within, or immediately adjacent to, the Stanislaus, Merced and Tuolumne Rivers banks and channels. As such, reduction of vegetation-disturbing activities would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Reduction of vegetation-disturbing activities would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road and within, or immediately adjacent to, the river banks and channels. Impacts would not occur. • Reduction of vegetation-disturbing activities would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • Reduction of vegetation-disturbing activities would not entail substantial ground disturbing activities (e.g., grading, excavation) and would actually result in fewer ground disturbing activities. As such, if reduction of vegetation-disturbing activities occurred on a Cortese Site (i.e., hazardous waste site list compiled pursuant to Government Code, § 65962), there would be no significant hazard to the public or environment as a result. Impacts would not occur.

Potential Environmental Effects of Reducing Vegetation-Disturbing Activities in Floodplains and Floodways	
Resource	Discussion
Hydrology and Water Quality	• Reduction of vegetation-disturbing activities could affect water quality if activities included in-water work. However, in-water work would be short term and only one or two persons would be in the river channel, and therefore water quality standards would not be violate. Impacts would not occur. • Reduction of vegetation-disturbing activities would not substantially deplete groundwater supplies or interfere substantially with groundwater recharge because these activities would not require groundwater and would not result in an increase in impervious surfaces. Impacts would not occur. • Reduction of vegetation-disturbing activities may alter the existing drainage pattern of the site or area or alter the course of a stream or river, depending on the action taken (i.e., fencing off cattle from a stream), but this would not result in substantial erosion or siltation on- or offsite or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite or alter the capacity of existing or planned storm water drainage systems. Reduction of vegetation-disturbing activities would be beneficial in stopping erosion and flooding because it would allow further establishment of riparian communities and vegetation. Impacts would not occur. • Reduction of vegetation-disturbing activities would not substantially increase the number of people exposed to the risk of flooding because these projects would not draw people to flood hazard locations. As such, these activities would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Reduction of vegetation-disturbing activities would not involve the construction of housing, therefore this activity would not place housing within a 100-year flood hazard area. Impacts would not occur. • Reduction of vegetation-disturbing activities would not involve the construction of structures. Therefore, this activity would not place structures which would impede or redirect flood flows within a 100-year flood hazard area. Impacts would not occur. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Reduction of vegetation-disturbing activities is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which reduction of vegetation-disturbing activities could result in a substantial degradation of water quality.
Land Use and Planning	• There would be no impact on land use and planning due to reduction of vegetation-disturbing activities. Implementation of the reduction measures would not conflict with any applicable land use plan, policy, or regulation including general plan, specific plan, local coastal program, or zoning ordinance adopted for the purpose of avoiding or mitigating an environmental effect. Reduction of vegetation-disturbing activities that take place within existing river banks and channels would be consistent with land use designations or zoning because frequently these areas are designated natural resource or open space areas by land use plans, and the reduction measures would enhance existing habitat for fish and wildlife species. Measures to reduce vegetation-disturbing activities would also not conflict with any applicable habitat conservation plan or natural community conservation plan which covers the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers such as the SJR Wildlife Refuge CCP and the SJMSCP. Impacts would not occur.

Potential Environmental Effects of Reducing Vegetation-Disturbing Activities in Floodplains and Floodways

Resource	Discussion
Mineral Resources	• Reduction of vegetation-disturbing activities would not result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or loss of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan because there would be no substantial construction activities. Impacts would not occur.
Noise	• Reduction of vegetation-disturbing activities would not result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or generate excessive ground-borne vibration or ground-borne noise levels because there would be no substantial construction activities and because the proximity to sensitive receptors (e.g., residences) is expected to be limited. Impacts would not occur.
Population and Housing	• Population and housing would not be affected by reduction of vegetation-disturbing activities because activities would not induce population growth, displace people or existing housing, or necessitate the construction of replacement of new housing. Impacts would not occur.
Public Services	• Reduction of vegetation-disturbing activities would not result in the need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services because they would not result in population growth or the need for these services. Impacts would not occur.
Recreation	• Reduction of vegetation-disturbing activities would not affect recreational facilities because these activity-reduction measures would not remove vegetation or result in substantial construction that could affect the use of existing recreational facilities. Reduction of vegetation-disturbing activities would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Reduction of vegetation-disturbing activities would not result in a significant increase in traffic because it would not require large numbers of people or vehicles to conduct studies or implement the reduction measures. Impacts would not occur. • Reduction of vegetation-disturbing activities would not result in an increase demand for air traffic or the need for airports because these activities would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Reduction of vegetation-disturbing activities would not involve the discharge of wastewater, construction of additional storm water drains, generate an increase in solid waste, nor require a water supply. Additionally, these activities would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur.

16.3.3 Gravel Augmentation

Gravel augmentation is the artificial addition of spawning-sized gravel to streams to increase the quantity and quality of spawning and incubation habitat where the natural processes of gravel recruitment have been disrupted by dams, regulated flows, gravel mining, and other instream activities (e.g., bank stabilization). In the Central Valley, gravel augmentation projects are generally focused on gravel-bed reaches of streams below mainstem dams where historical degradation of spawning habitat has been identified as a major limiting factor for salmon and steelhead populations (USFWS 2001 or AFRP 2002, 2003, 2004; see Bunte 2004).

The general approaches to spawning gravel augmentation include the following.

- Gravel injection, a passive approach in which relatively large amounts of spawning-sized gravel are dumped in channel areas where high flows can transport the gravel to downstream spawning areas.
- Spawning bed enhancement, an active approach in which spawning-sized gravel is either added directly to known spawning areas (e.g., riffles), and/or modified through mechanical grading, ripping, or cleansing (i.e., reducing fine sediment) to create or restore the streambed and hydraulic characteristics of functional spawning habitat.
- Hydraulic structure placement, an active approach which may be used in conjunction with spawning bed enhancement, entails placement of large woody debris, boulder clusters, weirs, or other structures to create localized hydraulic conditions conducive to gravel deposition and retention.

Different methods can be used to place and distribute spawning gravel depending on site constraints. Heavy construction equipment is typically used but various kinds of conveyor belts, slurries, high pressure pipes, helicopters, and cable lines also may be used depending on the project.

Cost Evaluation

Gravel augmentation can be achieved through the three approaches identified above. While site specific conditions influence the cost of the approach, generally gravel injection is the lower cost approach, while hydraulic structure installation is the higher cost approach. This section provides discussion of the general costs associated with the three approaches, and then summarizes actual costs associated with gravel augmentation projects in the Central Valley (Table 16-14, *Central Valley Project Improvement Act Spawning & Rearing Habitat Restoration Projects*).

The costs associated with gravel injection are primarily related to fuel costs for gravel delivery. These costs are estimated at $15–$20 per ton plus $0.16–$0.20 per mile to transport. Gravel injection is typically used where flows are high enough to mobilize the material such as downstream of a reservoir or on locations with easy access to the river for placement of the gravel (Cramer Fish Sciences 2010).

Spawning bed enhancement is more expensive than gravel injection because it typically requires engineering design. The cost of spawning bed enhancement is estimated at $25–$33 per ton ($19–$25 per cubic yard) (Bunte 2004). This cost does not include engineering design. The design involves choosing the appropriate location and gravel mix as the variability of gravel sizes is crucial for successful augmentation. For example, if the gravel is too large, female salmonids may be unable to mobilize enough substrate to build a high-quality redd or they may build shallow redds, resulting in higher risk of scour. If the gravel is too small, egg or alevin survival may be low if temperature and oxygen levels are compromised as a result of reduced redd permeability (Zeug et al 2014).

Hydraulic structure installation is generally the most expensive of the approaches because it requires engineering analysis and in-stream work with heavy equipment which results in necessary permits from different agencies that can take 6–18 months to obtain. Project costs for this approach can range from $1,500 to $100,000 depending on the complexity of the project, project length, and materials (Cramer Fish Sciences 2010).

The costs provided above do not include maintenance and monitoring which depend on the approach selected. A project's budget typically includes basic monitoring costs that would enable implementation of adaptive management appropriate for the size, scale, and site-specific conditions and needs. Adaptive management helps refine the actions needed to meet certain restoration objectives based on data obtained from monitoring (Cramer Fish Sciences 2010).

Table 16-14. Central Valley Project Improvement Act[a] Spawning & Rearing Habitat Restoration Projects

Project	Description	Construction/ Implementation[b]	Monitoring + Adaptive Mgt.[c]
Sacramento River Project	Annual placement of 10,000 tons of gravel for spawning and rearing habitat restoration – between Clear Creek & Keswick Dam	$795,000	$120,000
American River Project	Annual placement of 7,000 tons of gravel at Nimbus Basin on the American River	$745,000	$6,000 + $100,000
Stanislaus River Project	Annual placement of 3,000 tons of gravel at the Two Mile Bar or Upper Honolulu Bar along the Stanislaus River	$670,000	$15,000
Program Management & Support (for 3 projects over 2 fiscal years)		$450,000	

Source: Hannon et al 2013.

[a] The Central Valley Project Improvement Act of 1992 (CVPIA) is a collaboration of agencies that includes the Department of the Interior, Bureau of Reclamation, USFWS in collaboration with state and local governments, tribes and stakeholders.

[b] Costs provided are the requested funding for Fiscal Year 2015 and 2016. Costs represent the amount being cost-shared between the state and federal agencies in CVPIA.

[c] The adaptive management cost is intended to build a model and assemble information to create model parameters to identify restoration actions and monitoring priorities for the American River Project.

Environmental Evaluation

The primary sources of information for the following general description of gravel augmentation projects and associated environmental impacts were Bunte (2004), DWR (2004), NMFS (2013), and USFWS (2013). Additional references are cited below.

Summary of Potential Action

Pre-project assessment, planning, and design activities for gravel augmentation projects may include geomorphic surveys, topographic/bathymetric surveys, sediment sampling, hydrologic analyses, and hydraulic and sediment transport modeling. Integrated approaches utilizing quantitative hydraulic, sediment transport, and habitat modeling tools have been developed to facilitate the design process and improve success of spawning habitat rehabilitation projects (Pasternack et al. 2004; Wheaton et al. 2004a, 2004b).

The magnitude of construction impacts on vegetation, soils, streambed substrates, and water quality during construction activities depends on site selection and gravel placement methods (e.g., passive or active). Potential construction activities include clearing of vegetation to construct temporary roads, access, and staging areas; placement of temporary gravel berms or other structures to provide construction access and isolate work areas from the river; permanent placement of gravel, boulders and other flow or sediment control structures; and grading, ripping, and recontouring of newly deposited or existing gravel. Typical construction equipment includes graders, excavators, and loaders. Common environmental commitments or BMPs to avoid, minimize, or offset potential environmental effects may include seasonal work windows, preconstruction biological surveys; biological monitoring during construction; construction noise; traffic control; SWPPP; spill prevention, control, and countermeasure plan; and turbidity compliance monitoring.

Operation and maintenance of gravel augmentation projects may include periodic replenishment of gravel as needed. Post-project monitoring activities typically include monitoring and evaluation of key geomorphic, hydraulic, and biological parameters in an adaptive management framework.

Potential Environmental Effects

Construction of gravel augmentation projects may result in temporary and localized effects typically associated with construction activities, including a change in water quality, air quality effects, and ground and channel disturbance. Gravel placement would be located in areas that support spawning for special-status fish species such as Chinook salmon and steelhead. These areas are below the dams on the Stanislaus, Tuolumne, and Merced Rivers where most spawning occurs and gravel is lacking.

It is reasonable to assume that new gravel placement would be professionally installed by contractors familiar with such projects. Depending on the magnitude of the projects, construction could last from 1 to 12 weeks (i.e., up to 3 months) depending on the nature of the project and amount of gravel to be augmented (e.g., Feather River Gravel Supplementation Project duration is 3 months). Construction activities would occur during the dry season (typically June–October) when anadromous fish would not be spawning. BMPs for controlling sediment and contaminant release into waterbodies would be used to minimize impacts on water quality. Gravel augmentation sites would result in changes to hydraulics, channel substrate, and stream habitat types such as pools, runs, and riffles. However, all of these changes are expected to benefit aquatic biological resources.

Table 16-15, *Potential Environmental Effects of Gravel Augmentation*, summarizes the potential environmental effects associated with gravel augmentation. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this non-flow measure and is referenced in Table 16-15 where appropriate.

Table 16-15. Potential Environmental Effects of Gravel Augmentation

Potential Environmental Effects of Gravel Augmentation	
Resource	Discussion
Aesthetics	• Construction and operation of gravel augmentation projects would not be expected to significantly affect scenic vistas because they would be located within or immediately adjacent to existing river channels. Construction and operation of the augmented areas would not have a substantial adverse effect on a scenic vista. Construction may be observable for a temporary period of time when heavy equipment is used to transfer gravel in and around the project site. However, it is anticipated that the location of these projects would not be within close proximity to sensitive viewers (e.g., recreationists or residents) given the potential remote location of the projects within rivers. If sensitive viewers are located within close proximity, the temporary nature of construction and the fact that views would not be permanently changed would be such that significant impacts would not occur. Operation may be noticeable at first during the time it takes for natural processes such as establishment of vegetation and gravel movement to occur. After that, the river channel may be more aesthetically pleasing due to the enhanced gravel habitat and movement of the channel. Lighting is not expected to be used during gravel augmentation activities because the construction would occur during the day given the need to work within or immediately adjacent to the channels. This impact would be less than significant.
Agriculture and Forestry Resources	• Construction and operation of gravel augmentation projects would not be expected to be located on lands used for agriculture or forestry because they would be located within or immediately adjacent to existing river channels. There would be no conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use, conflict with existing zoning for agriculture use or a Williamson Act contract, conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Construction of gravel augmentation projects would likely result in emissions associated with construction equipment and construction worker vehicle trips. The quantity, duration, and the intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since construction of gravel augmentation projects does not require lengthy construction activities, the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the SJVAPCD regulations and established thresholds. Lead agencies (e.g., irrigation districts or municipal water purveyors) can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction of gravel augmentation projects would be

Potential Environmental Effects of Gravel Augmentation

Resource	Discussion
	inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction of gravel augmentation projects would not result in population or employment growth because these projects are habitat restoration projects for the benefit of special-status fish species. Therefore, construction of gravel augmentation projects would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • Operation of gravel augmentation projects would likely result in scheduled maintenance or monitoring vehicle trips. Given the limited number of vehicles and monitoring trips, over a longer timeframe, emissions from the vehicles would not be expected to prevent compliance with regulations or exceed thresholds established by SJVAPCD, conflict or obstruct implementation of the applicable air quality plan, violate any air quality standard, contribute substantially to an existing or projected air quality violation, or result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standards. Impacts would be less than significant. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). Gravel augmentation projects would not create objectionable odors affecting a substantial number of people. Impacts would not occur.
Biological Resources	• Construction of gravel augmentation projects would release sediment and possibly hazardous materials (e.g., oil or gas from construction equipment) into waterbodies, affecting water quality. Release of sediment can bury macroinvertebrates which are prey for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat. Operation of gravel augmentation projects would change aquatic habitat by changing river width, stream habitat types (riffles, pools, runs), and hydraulics. While construction may have some temporary significant impacts, gravel augmentation would have beneficial long-term effects on Chinook salmon and steelhead spawning habitat. Water quality measures such as monitoring turbidity during construction to ensure compliance with Basin Plan water quality objectives and construction BMPs would be implemented as either mitigation measures under CEQA or permit requirements and conditions. Furthermore, an MMP would be enforced after restoration is completed, which is part of permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. After construction is complete, the gravel augmented areas would need to be monitored to determine if the quantity and location of gravel was correct and to ensure the augmented areas are functioning as designed and benefiting Chinook salmon and steelhead. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction

Potential Environmental Effects of Gravel Augmentation

Resource	Discussion
	of gravel augmentation projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction of gravel augmentation projects would not interfere with the movement of native residential or migratory fish species and associated migratory corridors, or impede the use of nursery sites because any work done in the water would occur during June to October when fish are not spawning or migrating. Impacts would not occur. • The surrounding habitat on river banks may include riparian vegetation and/or wetlands. Riparian vegetation may have to be removed to facilitate heavy equipment operation. Wetlands may also be disturbed during construction activities. This would result in a temporary significant impact on riparian habitat and wetlands. Under operations, riparian habitat and wetlands would not be affected. Removal and/or disturbance of riparian and wetlands habitats would be compensated for at a ratio appropriate for the disturbance per standard permit requirements or conditions from U.S. Army Corps of Engineers, Central Valley Water Board, and other responsible agencies. This would reduce and minimize impacts on fish and wildlife species and their habitats. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction of gravel augmentation projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of gravel augmentation projects would be located in river reaches that support special-status fish species such as Chinook salmon and steelhead. These reaches are expected to have high potential for special-status plant species, animal species, and habitat, and support biological resources. Gravel augmentation projects would occur during the least sensitive periods of special-status species life stages (i.e., during the dry season, June–October), as required through either the CEQA process or through permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce potentially significant environmental effects of construction and operations on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • While construction may result in temporary localized adverse effects on special-status species, plants, and habitat, construction activities are highly unlikely to result in population level adverse effects for any species. As such, these activities are not expected to conflict with habitat conservation plans such as the SJR Wildlife Refuge CCP or the SJMSCP, which are meant to provide protection at the population level. In addition, conflicts with local policies as a result of construction are considered less than significant because of the temporary and localized nature. Finally, because gravel augmentation is expected to produce beneficial results for special-status fish and other wildlife species, ultimately gravel augmentation would not conflict with local policies protecting biological resources or with provisions of an

Potential Environmental Effects of Gravel Augmentation	
Resource	Discussion
	adopted habitat conservation plan or natural community conservation plan (e.g., SJR Wildlife Refuge CCP, SJMSCP). This would be a less-than-significant impact.
Cultural Resources	• Construction and operation of gravel augmentation projects would be within or immediately adjacent to existing river channels. While it is unknown if cultural resources (significant historical, archaeological, or paleontological resources) or human remains exist in these locations, these areas would not be excavated and ground disturbance would not occur, which are two of the primary mechanisms for affecting cultural resources or human remains. Gravel would be placed on the existing substrate in the river channel. Operation of gravel augmentation would have a very low potential to affect cultural resources because the gravel would be in the river and would be augmented periodically. Typically the river channels have had high levels of disturbance because of hydraulic conditions; and as such, there is a low potential for significant cultural resources or human remains to existing within the rivers. This would be a less-than-significant impact.
Geology and Soils	• The locations of gravel augmentation could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, gravel augmentation would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. Gravel augmentation would not bring people to the risk of earthquakes or geologic hazards, meaning the operation of the augmented areas would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur. • Project sites would be evaluated before construction begins for the potential of soil erosion in the design of the augmentation project. Construction would likely take place within stream channels and adjacent to rivers and in riparian areas. Erosion could take place depending on the site-specific soil characteristics, geology, area of disturbance by construction equipment, and construction equipment used. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant erosion or sediment effects associated with construction or operation of gravel augmentation projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.

Potential Environmental Effects of Gravel Augmentation

Resource	Discussion
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-12, augmentation of gravel would result in increased GHG emissions because heavy construction equipment would be used. While construction activities would be relatively limited and short term in duration, it is likely that gravel augmentation activities could result in a potentially significant GHG impact beyond the SJVAPCD ZEL. Depending on the level of construction activities and the potential operational lifespan of the project, construction-related GHG emissions could exceed SJVAPCD's ZEL and result in a potentially significant impact. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • During operation, heavy equipment may be needed to replenish gravel sites, but these would be limited activities of very short duration and would likely result in small quantities of GHG emissions. In addition, vehicles may be needed for monitoring or maintenance of restored areas. However, the trips would be limited, of very short duration, and over a long period of time (e.g., one trip every year). As such, they would likely result in small quantities of GHG emissions. However, GHG emissions may still exceed SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

Potential Environmental Effects of Gravel Augmentation	
Resource	Discussion
Hazards and Hazardous Materials	• Construction and operation of gravel augmentation would not be a hazard or provide a safety concern to public or public use airports or private airstrips because augmentation would be constructed and operated within or immediately adjacent to river channels, and would not result in the construction of tall structures. As such, construction and operation of gravel augmentation would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Construction and operation of gravel augmentation would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road and within or adjacent to river channels. Impacts would not occur. • Construction and operation of gravel augmentation projects would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • Construction of gravel augmentation projects could involve the temporary use of small amounts of hazardous materials, such as fuel to power construction equipment. There is a low potential for a hazardous materials spill associated with construction equipment to affect the environment given the short duration of construction and the generally limited number of construction equipment that would be used. However, given the projects would be within or immediately adjacent to existing river channels, Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due to hazards and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The precise location of where gravel augmentation would occur is not yet known; however, these projects could be constructed within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • The precise location of where gravel augmentation would occur is not yet known; however, gravel augmentation would not entail substantial ground disturbing activities (e.g., grading, excavation). As such, if gravel augmentation occurred on a Cortese Site (i.e., hazardous waste site list compiled pursuant to Government Code, § 65962), there would be no significant hazard to the public or environment as a result because if soil or groundwater contamination occurred it would not be released. Impacts would not occur.

Potential Environmental Effects of Gravel Augmentation	
Resource	Discussion
Hydrology and Water Quality	• Construction of gravel augmentation projects may temporarily affect water quality due to the placement of gravel in active river channels. Placing gravel and driving heavy equipment in and near the river channel could result in a temporary increase in turbidity. Due to the limited nature and occurrence of construction activities during the dry season, it is not expected that water quality standards for the protection of fish and wildlife would be violated because the timing of work construction windows (i.e., June–October) would avoid the most sensitive life stages of special-status fish species. Additionally, turbidity would be monitored to maintain compliance with Basin Plan water quality objectives. Construction of gravel augmentation projects would not alter the capacity of existing or planned storm water drainage systems, and would not provide substantial additional sources of polluted runoff. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of gravel augmentation projects would not deplete groundwater supplies or interfere substantially with groundwater recharge because these projects would not require groundwater during construction or operation and would not result in an increase in impervious surfaces. Impacts would not occur. • Operation of the gravel augmentation sites could alter the existing drainage pattern of the site or area. However, it is not expected to cause an increase in substantial erosion or siltation or result in flooding on- or offsite. In addition, operation of gravel augmentation sites would not exceed the capacity of existing or planned storm water drainage systems, and would not provide substantial additional sources of polluted runoff. Site design would take into account existing hydrology and channel geomorphology and gravel placement would be done so no erosion or flooding would occur. An MMP, which is part of the permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers, would be implemented to ensure no erosion is occurring and the gravel placement is functioning successfully. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Gravel augmentation projects would not substantially increase the number of people exposed to the risk of flooding because these projects would not draw people to flood hazard locations. As such, these projects would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Construction and operation of gravel augmentation sites would not involve the construction of housing, and therefore this activity would not place housing within a 100-year flood hazard area. Impacts would not occur. • Gravel augmentation projects would entail the placement of spawning-sized gravel and/or hydraulic structures (e.g., large woody debris, boulder clusters, weirs) within stream channels. Neither gravel nor hydraulic structures would impede or redirect flood flows within a 100-year flood hazard area. Site design would take into account existing

Potential Environmental Effects of Gravel Augmentation	
Resource	Discussion
	hydrology and channel geomorphology and gravel placement would be done so no flooding would occur. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Gravel augmentation is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of gravel augmentation projects could result in a substantial degradation of water quality.
Land Use and Planning	• Construction and operation of gravel augmentation projects would not physically divide an established community because they would be located in the existing river channels, or immediately adjacent to them, and communities are not established in these areas. Impacts would not occur. • Construction and operation of gravel augmentation sites would occur in existing river channels, or immediately adjacent to them, and would not conflict with land use designations or zoning. Frequently these areas are designated natural resource or open space areas by land use plans and gravel augmentation would be consistent with those designations because it would enhance existing habitat for fish and wildlife species. Impacts would not occur. • The following habitat conservation plans cover parts of the Stanislaus, Tuolumne, and Merced Rivers: SJR Wildlife Refuge CCP and the SJMSCP. These plans protect special-status species within the Stanislaus, Tuolumne, and Merced Rivers. As described in the Biological Resources section of this table, there would be some temporary construction impacts on adjacent riparian areas, but lead agencies could mitigate these temporary impacts through measures identified in Table 16-39. As such, no conflicts are expected with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations. Impacts would not occur.
Mineral Resources	• As mentioned in the Mineral Resources section in Table 16-12, there are known aggregate mines along the three eastside tributaries (Clinkenbeard 1999, Clinkenbeard 2012a and 2012b, Higgins and Dupras 1993, Rapp et al. 1977, and Smith and Clinkenbeard 2012). While mining within the active river channel is not typically performed, aggregate sites may be located in close proximity to the active river channel. Construction and operation of gravel augmentation could have potential to affect access to state or locally designated mineral resource areas. This is because the gravel augmentation sites would be within existing river channels and could cover mineral areas located downstream of the augmentation if the gravel moves downstream within the river channel. As discussed under the Biological Resources section of this table, an MMP would be enforced after restoration is completed, which is part of permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. Until such time that the potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. After construction, the gravel augmented areas would need to be monitored using the MMP to determine if the quantity and location of gravel was correct and to ensure the augmented areas are functioning as designed and benefiting Chinook salmon and steelhead. Movement of gravel would also be monitored to ensure it was not covering or removing access to existing important or designated mineral resources. If gravel movement covers or removes

Potential Environmental Effects of Gravel Augmentation

Resource	Discussion
	access to mineral resource areas, gravel augmentation could be re-evaluated and discontinued at the site. However, if gravel augmentation is not discontinued, impacts would remain significant and unavoidable.
Noise	• Construction of the gravel augmentation sites would create noise related to the use of heavy construction equipment and rock placement. The sites would be located in river channels, or immediately adjacent to them, where people generally do not live. It is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies due to the limited duration of construction and the remote location of these projects from populated areas. Excessive ground-borne vibration or ground-borne noise levels are also not expected due to the small nature of the projects and the standard type of construction equipment that would be used. If there was temporary elevated noise in excess of standards established in local general plans, noise ordinance, or applicable standards, it would occur during the day (as construction is not expected to occur at night) and for short periods of time within the day over a short duration (e.g., 1–12 weeks). Given the limited exposure of potential sensitive receptors to this potential temporary increase and low likelihood of potential sensitive receptors to exist because of the remoteness of the project sites, it is expected impacts would be less than significant. Operation of gravel augmentation sites would not create noise. There may be some maintenance activities, but that would not create a permanent increase in ambient noise. Impacts would not occur. • Projects would not be constructed near airports or airstrips so people would not be exposed to excessive noise levels. Impacts would not occur.
Population and Housing	• The construction and operation of gravel augmentation sites would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Furthermore, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • The construction and operation of gravel augmentation sites would not displace substantial numbers of people or existing housing, or necessitate the construction of replacement housing elsewhere because the sites would be located in, or immediately adjacent to, river channels. No homes or people would be displaced. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed above, the construction and operation of gravel augmentation sites would not involve an increase in population or housing. In addition, these actions would not include new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.

Potential Environmental Effects of Gravel Augmentation

Resource	Discussion
Recreation	• Construction of gravel augmentation sites would occur within, or immediately adjacent to, river channels. It is possible that recreational facilities would be located in areas where gravel augmentation sites would be located. If recreational facilities were located within very close proximity, construction of gravel augmentation sites may affect them; however, it is unlikely that there would be significant impacts on recreational facilities because construction would be temporary and limited (e.g., 1–12 weeks). And once construction is complete the river would be returned to similar conditions prior construction because the gravel would be submerged in the channel on the bottom of the river. Impacts would be less than significant. • Construction and operation of gravel augmentation sites would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Construction of gravel augmentation sites could result in some additional trips associated with construction workers. Depending on the location of the site, there could be an increase in traffic from construction workers. The temporary increased traffic during construction would likely not exceed local or regional road trip thresholds because the number of construction workers that gravel augmentation projects typically require is less than 30. Additionally, the duration of construction would be very short (e.g., 1–12 weeks). This would be a less-than-significant impact. Operation of gravel augmentation sites would not generate additional trips beyond those needed to maintain the sites. If maintenance activities are needed, they would be temporary and infrequent in nature and would not increase traffic. Impacts would not occur. • Construction of gravel augmentation sites would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Construction and operation of gravel augmentation sites would not exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of wastewater. Impacts would not occur. • Construction and operation of gravel augmentation would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur. • Construction and operation of gravel augmentation sites would not need the construction of additional storm water drains because the facilities would likely be built within, or immediately adjacent to, river channels and would not generate storm water. Impacts would not occur. • Construction and operation of gravel augmentation sites would not generate an increase in solid waste because activities are limited to gravel placement into an existing river channel. Impacts would not occur. • Construction and operation of gravel augmentation sites would not require a water supply. Impacts would not occur.

16.3.4 Enhance In-Channel Complexity

Enhancement of in-channel complexity focuses on the placement of large wood or boulder structures to assist in the restoration of degraded river ecosystems. A major factor that has contributed to historical decline and current status of Central Valley salmon and steelhead populations is the lack of habitat complexity resulting from dam construction and operation, channelization, levee construction, bank stabilization, and major land uses along major tributaries and mainstem reaches of the Sacramento and San Joaquin Rivers. Historically, extensive clearing of large wood from rivers and streams for water conveyance, navigation, and fish passage, and loss of riparian forests have greatly diminished the primary sources of large wood in spawning and rearing areas below mainstem dams (Bilby and Ward 1991). The loss of riparian vegetation, instream cover, and river-floodplain connectivity have greatly simplified riverine habitat and disrupted the natural processes that promote habitat diversity and complexity in Central Valley rivers and streams (NMFS 2008, 2014a).

Structural methods for enhancing habitat complexity in rivers span a wide range of designs that depend on project objectives and site-specific hydraulic, geomorphic, and ecological conditions. Such structures may be used to address other high-priority stream management needs (e.g., scour protection) or used in conjunction with other enhancement actions (e.g., spawning gravel augmentation) to achieve the project objectives. Three general categories of commonly used instream structures are cover structures, boulder structures, and log structures.

- Cover structures are often incorporated into other stream enhancement structures (e.g., log or boulder weirs) and include logs, root wads, tree bundles, and boulders that are typically placed in pools to serve as a direct source of cover for salmonids.
- Boulder structures include weirs, clusters, and deflectors that are typically placed in the active channel to concentrate the flow and create a diversity of hydraulic conditions promoting deposition (spawning gravel retention) and scour (pool formation), facilitating fish passage, and/or providing cover and resting areas for juvenile and adult salmonids.
- Log structures have similar applications as boulder structures and include a range of weirs, barbs, and engineered log jams.

Cost Evaluation

The costs for enhancing in-channel complexity through the installation of cover structures, boulder structures and log structures depend primarily on the size of the stream, channel hydrology, complexity of the design, site accessibility, cost of materials, and equipment needed to transport and install the material. One of the primary costs associated with enhancing in-channel complexity is the cost for large woody materials, such as logs, which is highly dependent on the type of tree selected. For example, Washington Douglas Fir is $100 per 1,000 board ft while the California Redwood costs about $510 for the same amount. The National Resources Conservation Service cost share practice standard estimates that the material cost for large woody material ranges between approximately $1,900 per acre and $924 per acre (Guhin and Hayes 2015). Table 16-16, *Engineered Log Structures and Large Woody Debris – Cost Estimates*, shows the approximate costs (low–high) based on the stream size.

Table 16-16. Engineered Log Structures and Large Woody Debris – Cost Estimates

Stream Size (cfs)	Cost[a] (Low–High)
Small stream (1–100 cfs)	\$10–\$40K
Medium stream (101–2000 cfs)	\$20–\$70K
Large stream (2000+ cfs)	\$10–\$80K

Source: Thomson and Pinkerton 2008.

cfs = cubic feet per second.

[a] Estimates identified above include construction, design, permitting, basic monitoring and routine maintenance (up to 2 years), reestablishing site to prior conditions and project management costs. These estimates assume purchased materials.

In 2008, the Lower Mokelumne River Joint Settlement Agreement (JSA) between EBMUD, USFWS, and CDFW included approval of\$25,663 in funding to UC Davis to conduct a study along the Lower Mokelumne River to determine the effectiveness of large woody materials in aiding fish habitat (Partnership Steering Committee 2008). The project consisted of placing 542 large wood pieces along 4.8 miles on the Lower Mokelumne River directly below the Camanche Dam where the flows averaged 350 cfs (Pasternack and Senter 2008).

Environmental Evaluation

The primary sources of information for the following general description of in-channel habitat enhancement projects and associated environmental impacts were NMFS (2000) and USBR and U.S. Army Engineer Research and Development Center (ERDC) (2016). Additional references are cited below.

Summary of Potential Action

Pre-project assessment, planning, and design activities for in-channel habitat enhancement projects may include geomorphic surveys, topographic/bathymetric surveys, sediment sampling, hydrologic analyses, and hydraulic and sediment transport modeling. Major design considerations include long-term stability and viability of the proposed structures relative to site-specific hydraulic conditions, scour and depositional effects, and ecological performance objectives.

The magnitude of construction impacts on native fish and wildlife species, vegetation, soils, streambed substrates, and water quality during construction activities depends on site selection, type of structure, and installation methods. Potential construction activities include clearing of vegetation to construct temporary roads and staging areas; placement of temporary gravel berms, cofferdams, or other structures to provide construction access and isolate work areas from the river; excavation and grading of the channel and banks to anchor in-stream structures; and placement and anchoring of boulders, logs, and root wads. Typical construction equipment includes graders, excavators, and loaders. Common environmental commitments or BMPs to avoid, minimize, or offset potential environmental impacts may include seasonal work windows, preconstruction biological surveys; biological monitoring during construction; construction noise and light reduction measures; traffic control; SWPPP; spill prevention, control, and countermeasure plan; and turbidity compliance monitoring.

Operation and maintenance of in-channel enhancement projects may include periodic inspections, repairs, and replacement of structural elements. Post-project activities typically include monitoring and evaluation of key geomorphic, hydraulic, and biological parameters in an adaptive management framework.

Potential Environmental Effects

Construction of in-channel enhancing structures may result in temporary and localized effects typically associated with construction activities, including impacts on water quality, air quality effects, and ground and channel disturbance. River channels may be graded to facilitate structures to be anchored into the bank substrate and to stabilize the structures in areas that support special-status fish species such as Chinook salmon and steelhead. These areas would be located below the dams on the Stanislaus, Tuolumne, Merced, and San Joaquin Rivers, where the rivers may lack complexity of habitats such as riffles and pools. Aquatic and riparian special-status species would be the most affected by construction and installation of in-channel enhancing structures. Operation of the structures would benefit aquatic species and may require maintenance if the structures move or do not create the expected habitat.

It is reasonable to assume that installation of in-channel enhancing structures would be professionally installed by contractors familiar with such projects. Depending on the magnitude of the projects, construction could last anywhere from several weeks to up to 12 weeks (i.e., 3 months). Construction activities would occur during the dry season (typically June–October) to avoid the most sensitive spawning and rearing periods of anadromous fish. BMPs for controlling sediment and contaminant release into waterbodies would be used and minimize potential impacts on water quality associated with sediment and hazardous materials. In-channel enhancing structures would result in changes to hydraulics, channel substrate, and stream habitats. These structures would also increase habitat for special-status fish species. In-channel enhancing structures are expected to benefit aquatic biological resources.

Table 16-17, *Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures*, summarizes the potential environmental effects associated with installation and operation of in-channel enhancing structures. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of these in-channel enhancing structures and is referenced in Table 16-17 where appropriate.

Table 16-17. Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures	
Resource	Discussion
Aesthetics	• Construction and operation of in-channel enhancing structures is not expected to significantly affect scenic vistas because they would be located within existing river channels. Construction and operation of the in-channel enhancing structures would not have a substantial adverse effect on a scenic vista. Construction may be observable for a temporary period of time when heavy equipment is used to grade banks, move sediment, and install structures around the project site. However, it is anticipated that the location of these projects would not be within close proximity to sensitive viewers (e.g., recreationists or residents) given the remote location of the projects within rivers. If sensitive viewers are located within close proximity, the temporary nature of construction would result in less-than-significant impacts because views would not be permanently changed. Operation of the project may be noticeable at first during the time it takes for re-establishment of vegetation and river channel natural movement. After that, the river channel may be more aesthetically pleasing. Lighting is not expected to be used during construction of in-channel enhancing structures since all construction would occur during the day. Impacts would be less than significant.
Agriculture and Forestry Resources	• Construction and operation of in-channel enhancing structures would occur within the footprint of existing river channels and not on lands used for agriculture or forestry. There would be no conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use, conflict with existing zoning for agriculture use or a Williamson Act contract, conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Construction of in-channel enhancing structures would likely result in emissions associated with construction equipment and construction worker vehicle trips. The quantity, duration, and the intensity of construction activities would have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since construction of in-channel enhancing structures does not require lengthy construction activities, the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the SJVAPCD regulations and established thresholds. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction of in-channel enhancing structures would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
	applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction of in-channel enhancing structures would not result in population or employment growth because these projects are habitat restoration projects for the benefit of special-status fish species. Therefore, construction of in-channel enhancing structures would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • Enhancing in-channel complexity would likely result in maintenance or monitoring trips by a few vehicles on a periodic schedule of limited duration. As such, emissions from maintenance vehicles are not expected to prevent compliance with regulations or exceed thresholds established by SJVAPCD, conflict or obstruct implementation of the applicable air quality plan, violate any air quality standard, contribute substantially to an existing or projected air quality violation, or result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standards. Impacts would be less than significant. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). Enhancing in-channel complexity would not create objectionable odors affecting a substantial number of people. Impacts would be less than significant.
Biological Resources	• Construction of in-channel enhancing structures would release sediment and possibly hazardous materials (e.g., oil or fuel from construction equipment) into waterbodies, affecting water quality. Release of sediment can bury macroinvertebrates which are prey for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat. In addition, due to the effects of in-channel construction, the movement of native resident or migratory fish species and the associated migratory corridors may be temporarily impeded. This would result in a significant impact. Water quality measures such as monitoring turbidity during construction, to ensure compliance with Basin Plan water quality objectives, and construction BMPs, would be implemented as either mitigation measures under CEQA or permit requirements and conditions. Further, an MMP would be enforced after restoration is completed, which is part of permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. The enhanced areas would need to be monitored to determine that the structures were functioning as designed and benefiting Chinook salmon and steelhead once construction is complete, under operating conditions. However, operation of in-channel enhancing structures would change aquatic habitat by changing river width, river habitat types (riffles, pools, runs), and hydraulics. In-channel enhancing structures would have beneficial long-term effects on Chinook salmon and steelhead habitat, including migratory corridors. Impacts under operation would be less than significant. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction and operation of in-channel

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
	enhancing structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of in-channel enhancing structures would be located in river reaches that support special-status fish species such as Chinook salmon and steelhead. This would result in take of special-status species. It is reasonable to assume that construction of in-channel enhancing structures would occur during the least sensitive periods of special-status species life stages, (i.e., during the dry season, June–October), as this would reduce and minimize impacts on aquatic species and would be required through either the CEQA process or through permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. However, if construction of the in-channel enhancement requires the construction and installation of cofferdams, these can injure or kill fish. If pile driving is need to construct the cofferdam, it can create noise impacts harmful to fish. Stranding within the cofferdams can occur if special-status fish species become trapped inside a dewatered area. Fish rescue in the dewatered area (seining, electrofishing) could injure or kill fish. These activities could result in take of special-status fish species. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce potentially significant environmental impacts on special-status biological resources from construction of in-channel enhancing structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even with mitigation measures, significant and unavoidable impacts may occur if the potential for take cannot be avoided or reduced or take occurs during construction. • The surrounding habitat on river banks may include riparian vegetation and/or wetlands. Riparian vegetation may have to be removed to allow heavy equipment movement and wetlands may also be disturbed during construction. This would result in a temporary significant impact on riparian habitat and wetlands. Under operations, riparian habitat and wetlands would not be affected. Removal and/or disturbance of riparian and wetlands habitats during construction would be compensated for at a ratio appropriate for the disturbance per standard permit requirements or conditions from the U.S. Army Corps of Engineers and the Central Valley Water Board. This compensation would reduce and minimize impacts on fish and wildlife species and their habitats. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on biological resources associated with construction of in-channel enhancing structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • While construction may result in temporary localized significant impacts on special-status species, plants, and habitat, construction activities are highly unlikely to result in population level adverse effects for any species. Therefore, these activities are not expected to conflict with habitat conservation plans such as the SJR Wildlife Refuge CCP or the SJMSCP, which are meant to provide protection at the population level. In addition, conflicts with local policies as a result of

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
	construction are not considered significant because of the temporary and localized nature of the effects. Impacts would be less than significant.
Cultural Resources	• Construction and operation of in-channel enhancing structures would occur within existing river banks and channels. Typically the river channels have had high levels of disturbance because of hydraulic conditions and there is a low potential for significant cultural resources (significant historical, archaeological, or paleontological resources) or human remains to exist within the river channels or immediately adjacent. However, it is unknown if cultural resources or human remains would exist at locations that could be used for anchoring or installing in channel structures, if the design of the project required that type of installation. Operation of in-channel enhancing structures would have a very low potential to affect cultural resources or human remains because the in-channel structures would primarily be located in the river and would be monitored. Where construction within areas that may contain cultural resources or human remains cannot be avoided an assessment should be conducted of the potential for damage to cultural resources prior to construction; this may require hiring a qualified cultural resources specialist to determine the presence of significant cultural resources. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant effects on cultural resources associated with construction of in-channel enhancing structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.
Geology and Soils	• The locations of new in-channel enhancing structures could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, in-channel enhancing structures would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, loss of topsoil, or landslides. Impacts would not occur. • Project design would evaluate sites for the potential of soil erosion to minimize erosion or sediment release that would not support the objectives of in-channel enhancement during construction or operation. However, given, construction would likely take place along adjacent rivers and in riparian areas, erosion could take place depending on the soil characteristics, geology, and area of disturbance. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant erosion or sediment impacts associated with construction or operation of in-channel enhancement projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Enhancement of in-channel complexity would not bring people to the risk of earthquakes or geologic hazards, meaning the operation of the enhanced areas would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur.

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-12, construction of enhanced in-channel complexity would generate GHG emissions because heavy equipment would be used for up to 12 weeks. While construction activities would be limited, it is likely that enhancement activities could result in a potentially significant GHG impact beyond SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • During operation, some vehicles may be needed for monitoring the enhanced areas. However, the trips would be limited, of very short duration, and over a long period of time (e.g., one trip every year). As such, they would likely result in less than significant quantities of GHG emissions. However, GHG emissions may still exceed SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
Hazards and Hazardous Materials	• Construction and operation of in-channel enhancing structures would not be a hazard or provide a safety concern to public or public use airports or private airstrips because the structures would be constructed and operated within the river banks and channels and would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, construction and operation of in-channel enhancing structures would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road and within the river banks and channels. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • Construction of in-channel enhancement projects could involve the temporary use of small amounts of hazardous materials, such as fuel to power construction equipment. There is a low potential for a hazardous materials spill associated with construction equipment given the limited duration of construction and the generally small number of construction equipment that would be used. However, since construction work would occur within river channels, Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due to hazards and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The precise location of where in-channel enhancement projects would be constructed is not yet known; however, these projects could be constructed within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation or grading activities. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962. These sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the DTSC for Calaveras, Tuolumne, or Mariposa Counties (CalEPA 2016). There were a total of 17 sites identified for Merced, San Joaquin, and Stanislaus Counties. In addition to these sites

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
	identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 500 leaking underground storage tanks designated as open in these counties (CalEPA 2016). There are approximately 55 facilities in these counties that have received CDOs/CAOs not identified as non-hazardous wastes, domestic wastewater, or domestic sewage (CalEPA 2016). It is not yet known precisely where in-channel enhancement would occur and if it would require excavation. However, if it occurred on a Cortese Site and required excavation there would be potential for release of existing soil or groundwater contaminants because of the ground disturbance. Were this to occur, impacts could be significant. Table 16-39 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • Enhancing in-channel complexity could require excavation. Utilities may be underneath the sites or adjacent to a site and may need to be relocated or avoided. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potential hazards associated with excavation around utilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.
Hydrology and Water Quality	• Construction of in-channel enhancing structures may temporarily affect water quality due to grading the river banks and channels. Placing and anchoring the structures and driving heavy equipment in and near the river channel could result in a temporary increase in turbidity. By scheduling construction activities during the dry season and isolating the work areas from surface water with cofferdams or some other means, it is expected that water quality standards would not be violated. Additionally, turbidity would be monitored to maintain compliance with Basin Plan water quality objectives. Operation of in-channel enhancing structures would not have a significant impact on water quality. Construction of in-channel enhancing structures would not provide substantial additional sources of polluted runoff. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction of in-channel enhancing structures would not exceed the capacity of existing or planned storm water drainage systems because it would not contribute substantial runoff to a storm water drainage system. In addition, construction would not provide substantial additional sources of polluted runoff. Impacts would not occur.

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
	• Construction and operation of in-channel enhancing structures would not deplete groundwater supplies or interfere substantially with groundwater recharge because activities would not use groundwater and would not result in an increase in impervious surfaces. Impacts would not occur. • Operation of in-channel enhancing structures could alter the existing drainage pattern of the site or area and could cause an increase in substantial erosion or siltation or result in flooding on- or offsite. Site design would take into account existing hydrology and channel geomorphology and installation of the structures would be done so no erosion or flooding would occur. An MMP, which is part of the permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers, would be implemented to ensure erosion is minimized and the enhancing structures are functioning successfully. Table 16-39 lists potential mitigation measures in the Geology and Soils section that lead agencies can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of in-channel enhancing structures would not substantially increase the number of people exposed to the risk of flooding because these activities would not draw people to flood hazard locations. As such, construction and operation of in-channel enhancing structures would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not involve the construction of housing, and, therefore this activity would not place housing within a 100-year flood hazard area. Impacts would not occur. • Enhancement of in-channel complexity would focus on the placement of large wood or boulder structures within stream channels. Neither construction nor operation of in-channel enhancing structures would impede or redirect flood flows within a 100-year flood hazard area. Site design would take into account existing hydrology and channel geomorphology, and enhancement of in-channel complexity would be done so no flooding would occur. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction of in-channel enhancing structures is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of in-channel enhancing structures could result in a substantial degradation of water quality.

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
Land Use and Planning	• Construction and operation of in-channel enhancing structures would not physically divide an established community because they would be located within existing river banks and channels, or immediately adjacent to them, and communities are not established in these areas. Impacts would not occur. • Construction and operation of in-channel enhancing structures would occur in existing river banks and channels and would not conflict with land use designations or zoning. Frequently these areas are designated natural resource or open space areas by land use plans and in-channel enhancing structures would be consistent with those designations because they would enhance existing habitat for fish and wildlife species. Impacts would not occur. • The following habitat conservation plans cover parts of the Stanislaus, Tuolumne, and Merced Rivers: SJR Wildlife Refuge CCP and the SJMSCP. These plans protect special-status species within the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers. As described in the Biological Resources section of this table, there would be some temporary construction impacts on adjacent riparian and/or wetland areas, but lead agencies would mitigate these temporary impacts through measures identified in Table 16-39. As such, no conflicts are expected with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations. Impacts would not occur.
Mineral Resources	• As mentioned in the Mineral Resources section of Table 16-12, there are known aggregate mines along the three eastside tributaries (Clinkenbeard 1999, Clinkenbeard 2012a and 2012b, Higgins and Dupras 1993, Rapp et al. 1977, and Smith and Clinkenbeard 2012). Construction and operation of in-channel enhancing structures are not likely to result in the removal or inability to access state or locally designated mineral resource areas. In-channel enhancing structures would be within existing river channels but would not be expected to cover existing mineral areas near operating mines. The locations selected for in-channel structures would be assessed to prevent them from being located within a state or locally designated mineral resource area. As such, construction and operation would not remove or result in significant impacts on these mineral resource areas. Impact would be less than significant.
Noise	• Construction of the in-channel enhancing structures would create noise related to the use of heavy construction equipment. The sites would be located where people generally do not live. It is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies. Excessive ground-borne vibration or ground-borne noise levels are also not expected due to the small nature of the projects and the type of construction equipment that would be used. If there was temporary elevated noise in excess of standards established in local general plans, noise ordinance, or applicable standards, it would occur during the day (as construction is not expected to occur at night) and for short periods of time within the day over a short duration (i.e., up to 12 weeks). However, given the temporary noise exposure to limited potential sensitive receptors, it is expected that noise impacts would be less than significant. Operation and maintenance of the in-channel enhancing structures would not create a permanent increase in ambient noise. This impact would be less than significant. • Projects would not be constructed near airports or airstrips so people would not be exposed to excessive noise levels. Impacts would not occur.

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
Population and Housing	• The construction and operation of in-channel enhancing structures would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Further, construction and operation of in-channel enhancing structures would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • The construction and operation of in-channel enhancing structures would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the sites would be located within river banks and channels. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location’s population increases, the need for additional or new public services and public service facilities generally increases. As discussed above, the construction and operation of in-channel enhancing structures would not involve an increase in population or housing. In addition, these actions would not include new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.
Recreation	• Construction of in-channel enhancing structures would occur within river banks and channels. It is possible that recreational facilities would be located in areas where in-channel enhancing structures would be placed. If recreational facilities were located within very close proximity, construction of in-channel enhancing structures may affect them; however, it is unlikely that there would be significant impacts on recreational facilities because construction would be temporary and limited in duration (i.e., up to 12 weeks). After construction is complete, in-channel enhancing structures would be located primarily submerged in the river channel. Impacts would be less than significant. • Construction and operation of in-channel enhancing structures would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Construction of in-channel enhancing structures could result in some additional trips associated with construction workers. Depending on the location of the site, there could be an increase in traffic from construction workers. The temporary increased traffic during construction would likely not exceed local or regional road trip thresholds, because the number of construction workers that in-channel enhancing structures typically require is less than 30. Impacts would be less than significant. • Operation of in-channel enhancing structures would not generate additional trips beyond those needed to maintain the sites. If maintenance activities are needed, it would be temporary and infrequent in nature and operation of the sites would not increase traffic. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.

Potential Environmental Effects of Installation and Operation of In-Channel Enhancing Structures

Resource	Discussion
Utilities and Service Systems	• Construction and operation of in-channel enhancing structures would not exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of wastewater. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not need the construction of additional storm water drains because the structures would be built within river channels and would not generate storm water. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not generate an increase in solid waste because activities are limited to modification of the river bank and channel. Impacts would not occur. • Construction and operation of in-channel enhancing structures would not require a water supply. Impacts would not occur.

16.3.5 Improve Temperature Conditions

Improving temperature conditions on the rivers can be done by operational and structural measures in upstream reservoirs. These have been identified as a priority conservation and recovery action in Central Valley rivers where coldwater reservoir supplies and operational flexibility may be sufficient to significantly improve water temperatures during critical migration, spawning, and rearing periods (NMFS 2014a). Currently, a number of naturally spawning populations of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead populations in reaches below these dams (i.e., New Melones Dam, New Exchequer Dam) are artificially maintained by cool water releases from upstream reservoirs. However, warm water temperatures during critical spring, summer, and fall migration, spawning, and rearing periods continue to be a major threat to these populations, especially in dry years, and will likely exert increasing stress on these populations based on current climate change predictions (NMFS 2014a).

Key non-flow actions for managing water temperatures released from these dams include cold water pool management, installation or modification of selective withdrawal structures (e.g., temperature curtains or shutters), and floodplain and riparian restoration (discussed previously in Section 16.3.1, *Floodplain and Riparian Habitat Restoration*). While additional flows in the rivers can also contribute to reducing water temperatures, flows are not considered in this evaluation because they are not considered a non-flow measure.

Cost Evaluation

Costs associated with floodplain and riparian restoration are discussed in Section 16.3.1, *Floodplain and Riparian Habitat Restoration*. Availability of cost information regarding actions to improve temperature conditions, such as installation or modification of selective withdrawal structures, is limited. Considerations that contribute to the cost generally include high construction costs.

The Lake Natoma Temperature Curtains Pilot Project estimated the cost to be $1,960,196 for a 3-year study that included the installation of 2 curtains (one curtain 700-ft long with a depth of 15–20 ft, second curtain 600-ft long with a depth of 20–25 ft). Lake Natoma is located within the Lower American River, approximately 23 miles upstream of the American River’s confluence with the Sacramento River in Sacramento County. The costs associated with this pilot project included: design, permitting and environmental review, project management, temperature monitoring, project installation and removal, and completion of a project analysis and report (Winternitz and Washburn 2002).

In 2011, installation of a temperature curtain took place at Whiskeytown Lake for a cost of $3 million; Whiskeytown Lake is approximately 10 miles west of the city of Redding in Shasta County. The new temperature curtain replaced a curtain from 1993 that had deteriorated and was no longer functional. The new temperature curtain is 2,400 ft long and drops into the lake 110-ft and is anticipated to achieve a 2–4 degree drop in water temperature (Gee et al. 2012).

Environmental Evaluation

The primary sources of information for the following general description of water temperature control projects and associated environmental impacts were EBMUD (2008), NMFS (2000), and USBR (1991, 2013).

Summary of Potential Action

Planning and evaluation for water temperature control projects generally includes the development and evaluation of a number of conceptual alternatives, including both operational and structural measures, to identify the most effective means of optimizing the use of cold water for protection of salmon and steelhead populations while maintaining existing water supply and power generation capabilities. Planning and evaluation of cold water management operations typically requires initial water supply and temperature modeling to evaluate the feasibility and potential effectiveness of alternative measures. Following implementation, the continued use of modeling and forecasting tools is generally required to adaptively manage available cold water supplies under variable hydrologic, water demand, and operational conditions to achieve the best possible release temperatures for fisheries protection.

The use of shutters or other structural devices, typically in conjunction with operational measures, has been shown to be an effective means to seasonally control the temperature of water released from major storage reservoirs (deep, seasonally stratified reservoirs) to protect salmon and steelhead populations in a number of Central Valley rivers (e.g., Sacramento River, American River, Feather River). The magnitude of construction impacts of temperature control structures on native fish and wildlife species, aquatic and terrestrial habitat, water quality, and other resources depends on the type of device (e.g., curtains, shutters), construction methods and materials, and the location of the structure relative to protected or sensitive resources. Installation of temperature control devices typically requires minimal ground clearing; most structures can be assembled offsite, hauled to the dam, and lowered into place from the top of the dam by a mobile crane. The construction methods vary in intensity depending on the dam size and the type of water control temperature device being installed. Barges are typically not used during construction of temperature curtains or shutters (e.g., Cougar Dam, Shasta Lake Water Resources Investigation). Assembly or attachment of the new structural components may require underwater cutting and assembly by divers. Installation of temporary barriers or dewatering is typically not necessary. Common environmental commitments or BMPs to avoid, minimize, or offset potential environmental effects may include seasonal work windows (e.g., non-flood control periods), preconstruction biological surveys; biological monitoring; construction noise and light reduction measures; traffic control; SWPPP; and a spill prevention, control, and countermeasure plan. Post-construction evaluation activities may include testing and evaluation of mechanical and electrical systems; water temperature monitoring and evaluation; and adaptive management to address unforeseen issues and optimize water temperature management relative to water supply, power generation, and biological objectives. Long-term operations and maintenance activities may include regular or periodic inspections, repairs, cleaning, and sediment and debris management.

Potential Environmental Effects

Construction of water temperature control structures may result in temporary and localized effects typically associated with construction activities, including impacts on water quality and air quality. It is assumed water temperature control structures could be implemented on the dam structures of New Melones, New Don Pedro, and New Exchequer on the Stanislaus, Tuolumne, and Merced Rivers respectively, where the reservoirs store water above the mainstem rivers. Aquatic resources would be the most affected by installation or implementation of water temperature control measures, primarily during installation. Operation of the water temperature control structures would benefit aquatic species by reducing the temperature of water released from the reservoirs downstream in the Stanislaus, Tuolumne, and Merced Rivers. Maintenance would be required to ensure proper operation of the water temperature control structures.

It is reasonable to assume that installation of water temperature control structures would be professionally installed by contractors familiar with such projects. Depending on the magnitude of the structures, construction could last up to 4 years with activities occurring up to 5 months per year. Construction activities would be expected to occur during the dry season (e.g., typically June–October) to avoid the flood control season and minimize exposure of sensitive fish and wildlife species to disturbance. BMPs for controlling sediment and contaminant release into waterbodies would be used to minimize potential impacts on water quality associated with hazardous materials that may potentially be used during construction (e.g., fuels and oils for construction equipment). Water temperature control structures or a change in reservoir releases would result in decreases in water temperature. A decrease in water temperature would be beneficial for Chinook salmon and steelhead migratory, spawning, and rearing habitat.

Table 16-18, *Potential Environmental Effects of Improved Temperature Conditions*, summarizes the potential environmental effects associated with construction and operation of water temperature control structures. Those impacts associated with floodplain or habitat restoration are identified in Table 16-12, *Potential Environmental Effects of Floodplain and Riparian Habitat Restoration,* and are not incorporated into Table 16-18. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this non-flow measure and is referenced in Table 16-18 where appropriate.

Table 16-18. Potential Environmental Effects of Improved Temperature Conditions

Potential Environmental Effects of Improved Temperature Conditions	
Resource	Discussion
Aesthetics	• Construction may be observable for a limited period of time when heavy equipment is used to install the structures behind the dams. While this could be visible around scenic areas around the reservoir, it would not permanently alter the scenic vistas or aesthetic experience of sensitive viewers because the construction equipment would be removed and the sites restored to their previous conditions once construction is complete. Lighting is not expected to be used during construction of water temperature control structures because generally most construction would occur during the day. However, there may be a need for 24-hour construction for a short period of time. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction lighting. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Operation of water temperature control structures would not be expected to have a significant impact on scenic vistas because they would be located underwater at existing dams. Impacts would be less than significant.
Agriculture and Forestry Resources	• Construction and operation of water temperature control structures are not expected to be located on lands used for agriculture or forestry because they would be located within the footprint of existing dams. There would be no conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use, conflict with existing zoning for agriculture use or a Williamson Act contract, conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Construction of water temperature control structures would likely result in emissions associated with construction equipment and construction worker vehicle trips, and fugitive dust emissions from ground disturbance, potentially at a laydown area. The quantity, duration, and the intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Similar to the discussion in Table 16-11b, *Potential Environmental Effects of New Surface Water Supplies,* emissions could be generated in the MCAB and GBVAB and depending on the air district and the criteria used, could exceed thresholds. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction of water temperature control structures would be

Potential Environmental Effects of Improved Temperature Conditions

Resource	Discussion
	inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction of water temperature control structures would not result in population or employment growth because these projects are habitat restoration projects for the benefit of special-status fish species. Therefore, construction of water temperature control structures would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • Construction and operation of water temperature control structures would not generate odors because the facility would exist behind a dam and not be located where people frequent. As such, impacts would not occur.
Biological Resources	• Construction of water temperature control structures would release sediment and possibly hazardous materials (e.g., oils or fuels from construction equipment) into waterbodies, temporarily affecting water quality. Dredging above the dam to clear sediment that may have settled against the dam would release sediment. Release of sediment into the river below the dam can bury macroinvertebrates which are prey for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat. Water quality measures such as monitoring turbidity and assessing water quality measurements (i.e., water temperature, dissolved oxygen) below the dam during construction should occur to avoid effects on aquatic resources and to ensure compliance with Basin Plan water quality objectives, and construction BMPs, would be implemented as either mitigation measures under CEQA or permit requirements and conditions. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on biological resources associated with construction of water temperature control structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction of water temperature control structures would not interfere with the movement of native residential or migratory fish species and associated migratory corridors, or impede the use of nursery sites because any work done in the water would occur during June to October when fish are not spawning or migrating. Impacts would not occur. • Operation of water temperature control structures would change aquatic habitat by changing water temperature. The change in water temperature is expected to be beneficial for Chinook salmon and steelhead. Overall, the project may have some temporary significant impacts during construction, but beneficial long-term effects. Water temperature control structures are not expected to have a substantial adverse effect, either directly or through habitat modifications on special-status species. Operation of water temperature control structures is expected to have a beneficial effect on special-status fish species by providing water temperatures that would create better conditions for migration, spawning, and rearing. During operation, an MMP would be implemented to ensure water temperatures are within appropriate ranges for special-status fish and other aquatic species. Monitoring is part of permitting requirements and conditions by

Potential Environmental Effects of Improved Temperature Conditions

Resource	Discussion
	resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. To ensure this, lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on biological resources associated with operation of water temperature control structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of water temperature control structures would be located in river reaches that support special-status fish species such as Chinook salmon and steelhead. These areas are expected to have high potential for special-status plant species, animal species, and habitat, and support biological resources. It is reasonable to assume that construction of water temperature control structures would occur during the least sensitive periods of special-status species life stages, (i.e., during the dry season, June–October), as this would reduce and minimize impacts on aquatic species and would be required through either the CEQA process or through permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce potentially significant environmental construction and operations impacts on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.
	• The surrounding habitat, outside of the area of reservoir fluctuation, may include riparian vegetation and/or wetlands. The areas around the reservoirs have maintenance roads and access areas for maintenance workers, which are cleared of vegetation. These areas could be used for construction staging and laydown and would not affect riparian vegetation or wetlands. If riparian vegetation or wetlands are removed or disturbed, they would be compensated for at a ratio appropriate for the disturbance per standard permit requirements or conditions from the U.S. Army Corps of Engineers and the Central Valley Water Board. This compensation would ensure fish and wildlife species and their habitats are protected. Under operations, wetlands and riparian vegetation would not be affected because the water temperature control device would be located in the reservoir. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental impacts associated with construction of water temperature control structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • While construction may result in temporary localized significant impacts on special-status species, plants, and habitat, construction activities are highly unlikely to result in population level adverse effects for any species. As such, these activities are not expected to conflict with habitat conservation plans such as the SJR Wildlife Refuge CCP or the SJMSCP, which are meant to provide protection at the population level. In addition, conflicts with local policies as a result of construction are not considered significant because of the temporary and localized nature of the effects. Because temperature control devices are expected to produce beneficial results for special-status fish species, ultimately the water

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Resource	Discussion
	temperature devices would not conflict with local policies protecting biological resources or conflict with provisions of an adopted habitat conservation plan or natural community conservation plan, such as the SJR Wildlife Refuge CCP or the SJMSCP. This impact would be less than significant.
Cultural Resources	• Construction and operation of water temperature control structures would be within existing dam footprints. With the exception of the New Melones, New Don Pedro, and New Exchequer dams themselves, it is unlikely that cultural resources (significant historical, archaeological, or paleontological resources) exist in these locations, because the areas where the dams were constructed are highly disturbed and no further ground disturbing activities or excavation is required to install the temperature control structures. However, New Melones, New Don Pedro, and New Exchequer dams are reasonably within or beyond the 50-year threshold to be considered for evaluation for listing in either the National or state historical registers. While the temperature improvement devices could be considered needed as part of the normal operation of these dams, depending on the device selected, the design and the size of it, a determination may need to be made of the potentially significant historic or non-historic nature of the dams and whether the device would affect the significance of the potential historic nature and, in so doing, result in a significant impact. California Public Resources Code Section 21084.1 and California Code of Regulations Section 15064.5 subd. (a) maintain that the lead agency shall consider the eligibility of these structures for listing in the California Register of Historic Resources despite the addition of a temperature control device that may have no physical impact on the dam(s). Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on cultural resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Geology and Soils	• Because the dams are already constructed, the soils and geology are stable to support the existing dams. Water temperature control structures would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. Water temperature control structures would not bring people to the risk of earthquakes or geologic hazards, meaning the operation of the structures would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would be less than significant.
Greenhouse Gas Emissions	• Construction of water temperature control structures would result in increased GHG emissions because heavy equipment would be used. Given the duration of construction (up to 4 years with activities occurring up to 5 months per year). Similar to the discussion in Table 16-11b, the following APCDs do not have applicable GHG thresholds: CCAPCD, MCAPCD, TCAPCD. For air districts in which there is no adopted GHG threshold, the ZEL for SJVAPCD could be applied. While construction activities would be limited, it is likely that water temperature control structures construction activities could result in a potentially significant GHG impact beyond the SJVAPCD's ZEL. Depending on the level of construction activities and the potential operational lifespan of the project, construction-related GHG emissions could exceed these values and result in a potentially significant impact. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable,

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	consistent with State CEQA Guidelines Section 15091. • During operation, vehicles may be needed for maintenance. The trips would be anticipated to be limited in number, of short distance and duration, and over a long period of time (e.g., one trip every year). As such, maintenance trips would likely result in small quantities of GHG emissions. However, GHG emissions may still exceed SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

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Resource	Discussion
Hazards and Hazardous Materials	• Construction of water temperature control structures could possibly create a hazard if fuel trucks were used to transport fuel to the project sites. Gas and diesel are not acutely hazardous, and storage, handling, and disposal of these materials is regulated by local, county, and state laws. Although transportation and use of hazardous materials would occur, required safety protocols would be followed, mitigation measures and BMPs would be implemented, and the materials would be handled and transported appropriately to reduce the likelihood of a foreseeable accident involving the release of hazardous materials into the environment. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction of water temperature control structures would not emit hazardous emissions or handle hazardous materials, substances or waste within one-quarter mile (0.25 miles) of an existing school because all construction would occur near the dams. No schools are located within one-quarter mile of a dam. Impacts would not occur. • Construction and operation of water temperature control structures would not be located on a hazardous materials site, including a Cortese Site, because the structures would be located within the reservoirs or on the dam structure of the reservoirs. Impacts would not occur. • Construction and operation of water temperature control structures would not be a hazard or provide a safety concern to public or public use airports or private airstrips because the structures would be constructed and operated within the dams and would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, construction and operation of water temperature control structures would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Construction and operation of water temperature control structures would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road within the dams. Impacts would not occur. • Construction and operation of water temperature control structures would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur.
Hydrology and Water Quality	• Construction of water temperature control structures may temporarily affect water quality due to removing sediment buildup behind the dams before installation of the structures. Dredging could release sediments into the reservoir and could be discharged downstream of the dam. Resulting turbidity could cause a temporary exceedance of applicable water quality standards. Turbidity would be monitored to maintain compliance with Basin Plan water quality objectives. Operation of the water temperature control structures would decrease water temperatures and this would be a beneficial effect for Chinook salmon and steelhead in the mainstem of the river. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on water quality during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts

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Resource	Discussion
	could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of water temperature control structures would not deplete groundwater supplies or interfere substantially with groundwater recharge because these projects would not require groundwater supplies and would not result in an increase in impervious surfaces. Impacts would not occur. • Operation of the water temperature control structures would not alter the existing drainage pattern of the site or area nor cause an increase in substantial erosion or siltation, substantial runoff, or result in flooding on- or offsite because it would operate within the reservoir. Installation of the structures would be done so no erosion or flooding would occur because it is likely the reservoirs would be drawn down to allow construction in the dry areas as much as possible. Additionally, an MMP would be implemented after restoration is completed, which is part of permitting requirements and conditions by resource agencies including USFWS, NMFS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers to ensure all of the structures are working as designed. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of water temperature control structures would not substantially increase the number of people exposed to the risk of flooding because these structures would not draw people to flood hazard locations. As such, construction and operation of water temperature control structures would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Construction and operation of water temperature control structures would not involve the construction of housing, and therefore this activity would not place housing within a 100-year flood hazard area. Impacts would not occur. • Construction and operation of water temperature control structures would occur within a reservoir and existing dams. The water temperature control structures would not impede or redirect flood flows within a 100-year flood hazard area. Impacts would be less than significant. • Construction and operation of water temperature control structures would occur in existing dams and would not create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems. Impacts would not occur. • Operation of water temperature control structures would not create or contribute runoff water. Impacts would not occur. • Construction of water temperature control structures is not expected to provide substantial additional sources of polluted runoff because these activities would occur primarily within existing dams. However, construction equipment would be required and, as a result, hazardous materials (e.g., fuels, lubricants, diesel) may be used during construction. While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it result in a significant impact. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water

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Resource	Discussion
	purveyors) can and should implement to reduce potentially significant impacts on water quality associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Although construction and operation of temperature control structures would occur at reservoirs, these activities would not cause in seismic ground shaking to generate in-reservoir seiches. Furthermore, these activities would not result in an increase in the potential for a seiche to occur, as the reservoirs could already experience a seiche under baseline conditions. Impacts would not occur. • There are no other ways in which construction or operation of temperature control structures could result in a substantial degradation of water quality.
Land Use and Planning	• Construction and operation of water temperature control structures would not physically divide an established community. Impacts would not occur. • Construction and operation of water temperature control structures would occur in existing dams and would not conflict with land use designations or zoning. Frequently these areas are designated natural resource or open space areas by land use plans and would be consistent with those designations because it would enhance existing habitat for fish species. Impacts would be less than significant. • The SJMSCP covers parts of the Stanislaus, Tuolumne, and San Joaquin Rivers. This plan protects special-status species within the San Joaquin, Stanislaus, and Tuolumne Rivers. Operation of water temperature control devices would not affect special-status species and would be beneficial. As such, no conflicts are expected with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations. Impacts would be less than significant.
Mineral Resources	• Construction and operation of water temperature control structures are not expected to result in the removal or inability to access state or locally designated mineral resource areas. This is because the water temperature control structures would be behind (i.e., upstream of) existing dams and would not affect mineral areas. Impacts would not occur.
Noise	• Construction of the water temperature control structures would create noise related to the use of heavy construction equipment. The sites would be located behind (i.e., upstream of) dams, and within the reservoirs, where people do not live. As such, it is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies. Excessive ground-borne vibration or ground-borne noise levels are also not expected due to the fact that construction would primarily be in the water with equipment on land. While there may be temporary elevated noise in excess of standards established in local general plans, noise ordinance, or applicable standards, it would occur during the day (as construction is not expected to occur at night) and for short periods of time within the day. Given the relatively limited exposure of potential sensitive receptors

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Resource	Discussion
	to this potential temporary increase in noise, and low likelihood of potential sensitive receptors to exist because of the location of construction, it is expected impacts would be less than significant. While it is not anticipated that potential sensitive receptors would be subject to excessive noise, Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce noise impacts during construction. However, it is likely that impacts could be mitigated to less than significant once implemented. • Operation of the water temperature control structures would not create noise. There would be maintenance activities, but they would not create a permanent increase in ambient noise. This impact would be less than significant. • Water temperature control structures would not be constructed near airports or airstrips so people would not be exposed to excessive noise levels. Impacts would not occur.
Population and Housing	• The construction and operation of water temperature control structures would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Further, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • The construction and operation of water temperature control structures would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere. No homes or people would be displaced. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, the construction and operation of water temperature control structures would not involve an increase in population or housing. In addition, these actions would not include proposals for new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.
Recreation	• Construction and operation of water temperature control structures would occur behind (i.e., upstream of) dams. It is unlikely recreational facilities would be located near dams because recreational boating and fishing are typically not allowed near the dam structures. Impacts on recreational facilities are not anticipated. Construction and operation of water temperature control structures would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur.

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Resource	Discussion
Transportation and Traffic	• Construction of water temperature control structures could result in additional trips associated with construction workers. Depending on the location of the site, there could be an increase in traffic from construction workers. The temporary increased traffic during construction would likely not exceed local or regional road trip thresholds, because the number of construction workers that work on water temperature control structures typically is less than 30. This impact would be less than significant. • Operation of water temperature control structures would not generate additional trips beyond those needed to maintain the structure. If maintenance activities are needed, they would be temporary in nature and operation of the structures would not affect traffic. Impacts would be less than significant. • Construction and operation of water temperature control structures would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Construction and operation of water temperature control structures would not exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of wastewater. Impacts would not occur. • Construction and operation of water temperature control structures would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur. • Construction and operation of water temperature control structures would not need the construction of additional storm water drains because the structures would be built behind the dams and would not generate storm water. Impacts would not occur. • Construction and operation of water temperature control structures would not generate an increase in solid waste. Impacts would not occur. • Construction and operation of water temperature control structures would not require a water supply. Impacts would not occur.

16.3.6 Fish Passage Improvements – Fish Screens

NMFS (2014a) identified entrainment of juvenile salmonids at unscreened or inadequately screened water diversions as a major factor contributing to historical declines and current status of listed Central Valley Chinook salmon and steelhead. Consequently, a major focus of species protection and recovery efforts has been screening of water diversions, with a higher priority placed on the largest diversions. However, there are many smaller diversions (mostly agricultural) that remain unscreened (Herren and Kawasaki 2001). It is generally recognized that modern fish screens are effective in preventing entrainment of juvenile salmonids but information is lacking to evaluate the overall survival and population-level benefits of fish screens (Moyle and White 2002, Vogel 2013).

Fish screen design varies widely depending on site-specific engineering, hydraulic, and fish protection objectives and requirements. Common positive barrier screen types include flat plate, drum, traveling, cylindrical, and inclined screens. Fish screen projects where NMFS, USFWS, and CDFW have jurisdiction must be developed in consultation with these agencies and in accordance with established design, operational, and maintenance criteria and guidelines (e.g., NMFS 2011).

Cost Evaluation

The costs for fish screens vary significantly depending on the size of the existing intake. Typically, screening smaller or private intakes that primarily serve agricultural uses are less costly when compared to screening large intake projects that primarily serve municipal and industrial uses. Agricultural diversions (with an average diversion rate of 10 cfs) have an estimated cost of $75,000 per diversion (unit cost of $7,500/cfs) (URS Corporation and Jack R. Benjamin & Associates 2011). Capital costs for agricultural diversion screens in the western United States can range between $3,000 and $20,000 per cfs, with maintenance and operations costs ranging between $3,000 and $5,000 per year (FCA 2016).

The Anadromous Fish Screen Program (AFSP) under the Central Valley Project Improvement Act (CVPIA) has funded several fish screen projects in California. The most recent ones are listed below.

- Natomas Mutual Sankey Fish Screen Project (total cost $45.975 million) located off the left bank of the Sacramento River replaced existing unscreened diversions with a consolidated 434 cfs fish screen and intake facility (USBR and USFWS 2014).
- Reclamation District (RD) 2035/Woodland Davis Clean Water Agency Joint Intake and Fish Screen (estimated cost of $44 million) located off the right bank of the Sacramento River replacing unscreened diversion with a consolidated 400 cfs fish screen and intake facility to provide water to irrigate approximately 15,000 acres of crops and serve the cities of Davis, Woodland, and the University of California, Davis campus (USBR and USFWS 2014, Wilcox 2014).

Another large municipal intake that has been screened in the Central Valley is the Davis Ranches Fish Screen Project, located in Colusa County at RM 132.5. This fish screen consisted of installing a self-cleaning, cylindrical, brushed intake fish screen with a retrieving system. The cost for this project is $414,904 which includes planning, design, project management, construction, installation, and monitoring. Table 16-19, *Design and Construction Costs Davis Ranches Site 2 Pump 4 & 5 Project*, provides a more detailed breakdown of the costs for this project.

Table 16-19. Design and Construction Costs Davis Ranches Site 2 Pump 4 & 5 Project

Cost Category	Davis Ranches Site 2, Pumps 4 &5[a]
Design & construction of fish screen	$310,964.00
Eng. review, inspection & documentation, permit costs	$24,000.00
Accounting & project management & monitoring	$79,940.00
Total	**$414,904.00**

Source: Griffith 2001.

Costs represent the total costs over 2 years.

Environmental Evaluation

The primary sources of information for the following general description of fish screen projects and associated environmental impacts were USFWS (2004), USBR (2006b), NMFS (2004, 2011). Additional references are cited below.

Summary of Potential Action

The design process for fish screen projects may include hydrologic and hydraulic data collection and analysis, debris and sediment loading assessments, and biological investigations. Key design considerations include screen placement (e.g., in- or off-river); screen size, orientation to flow, and hydraulics; debris and sediment management (e.g., screen cleaning systems); size, life history, behavior, and swimming ability of the target species; ancillary fish guidance and protection facilities (e.g., bypass systems); and operation and maintenance schedules.

The magnitude of construction impacts of fish screen projects on native fish and wildlife species, aquatic and terrestrial habitat, water quality, and other resources depends on the type, size, and location of the intake; construction methods; and proximity of other protected or sensitive resources. There are 112 diversions on the Merced River, 51 on the Tuolumne River, 117 on the Stanislaus River, 36 diversions on the SJR between the Merced and Tuolumne Rivers, and 8 diversions on the SJR between the Tuolumne and Stanislaus Rivers and between the Stanislaus River and Vernalis. This is a total of 324 diversions that could be screened depending on project-specific circumstances. These diversions are used for hydropower and irrigation. The minimum diversion is 1 cfs (East Stanislaus Resources Conservation District) and ranges up to 6,000 cfs (hydropower at New Melones Dam). Replacing, relocating, or constructing new fish screens may include clearing of vegetation to construct temporary roads, staging, and storage areas; placement of temporary structures (e.g., cofferdams) to isolate work areas from flowing water; clearing, grading, and armoring of the channel and banks; and pile driving. Typical construction equipment includes excavators, pile drivers, bulldozers, dump trucks, and front-end loaders. Generally the projects are relatively small in size and only require a construction crew of 5–10 people.

Common environmental commitments or BMPs to avoid, minimize, or offset potential environmental effects may include seasonal work windows (e.g., low flow periods); preconstruction biological surveys; erosion and sediment control measures; biological monitoring; construction noise and light reduction measures; traffic control; SWPPP; spill prevention, control, and countermeasure plan; and turbidity compliance monitoring.

Post-construction evaluation activities may include testing and evaluation of mechanical and electrical systems, hydraulic evaluations, and biological evaluations (e.g., fish entrainment monitoring). Long-term operations and maintenance activities may include regular or periodic inspections, repairs, cleaning, and sediment and debris management to ensure the effectiveness of the screen over the design life of the facility.

Potential Environmental Effects

Some of the irrigation diversions in the Central Valley are relatively small (<5 cfs) and the scale and magnitude of potential impacts associated with screening these diversions are such that they could meet the requirements of a categorical exemption under CEQA. CEQA allows categorical exemptions for classes of projects which have been determined not to have a significant effect on the environment. (Pub. Res. Code, § 21084.) Specifically, the following types of facilities and activities are exempt under a Class 1 or Class 3 categorical exemption.

- Minor alterations of the existing public or private structure without expanding existing uses.
- Installation of small new equipment and facilities.

In addition, Class 2 categorical exemptions allow for the replacement or reconstruction of existing facilities where the new structure will be located on the same site and will have the same purpose and capacity as the structure replaced. Some fish screen projects could meet the requirements for this exemption.

If the screening project would not meet the requirements of a categorical exemption, depending on the size of the intake and the needed screen, construction of fish screens may result in temporary and localized effects typically associated with construction activities, including a change in water quality, air quality effects, and ground and channel disturbance. If cofferdam placement and dewatering is needed, this could result in special-status fish species becoming stranded within the cofferdam area. A rescue and relocation of all fish species would be needed within the isolated areas. This could result in injury or mortality of special-status fish species. Additionally, pile driving may be needed for structure and/or cofferdam installation. Noise levels could affect special-status fish species. River banks or channels may be graded to facilitate structures in areas that support special-status fish species such as Chinook salmon and steelhead. Riprap may need to be placed around the intake structures. These areas would be located below the dams on the Stanislaus, Tuolumne, Merced, and Lower San Joaquin Rivers, where unscreened diversions occur. Aquatic resources would be the most affected by installation of fish screens. Operation of the screens would benefit special-status fish species and would require maintenance. Maintenance would occur when needed and would include cleaning the screen and regular or periodic inspections.

It is reasonable to assume that installation of fish screens will be professionally installed by contractors familiar with such projects. Depending on the magnitude of the projects, construction could last anywhere from several weeks to several months, but generally less than 6 months. Construction activities would occur during the dry season (typically June–October), when anadromous fish would not be spawning. BMPs for controlling sediment and contaminant release into waterbodies would be used to minimize potential effects on water quality associated with sediment and hazardous materials. Mitigation measures to minimize stranding and protect fish from injury and mortality from pile driving noise, cofferdam installation, and riprap placement would be implemented. Operation of fish screens would result in changes to hydraulics and stream habitats by the addition of riprap around the intake structures. Fish screens would help decrease entrainment of special-status fish species and other fish species. Adding fish screens is expected to benefit aquatic biological resources.

Table 16-20, *Potential Environmental Effects of Fish Passage Improvements—Fish Screens*, summarizes the potential environmental effects associated with improving fish passage with fish screens. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this non-flow measure and is referenced in Table 16-20 where appropriate.

Table 16-20. Potential Environmental Effects of Fish Passage Improvements—Fish Screens

Potential Environmental Effects of Fish Passage Improvements—Fish Screens	
Resource	Discussion
Aesthetics	• Construction and operation of fish screens would not be expected to significantly affect scenic vistas because the screens would be located within existing river channels. Construction and operation of the fish screens would not have a substantial adverse effect on a scenic vista. Construction may be observable for a temporary period of time when heavy equipment is used to grade banks, move sediment, and install structures. Lighting is not expected to be used during construction of fish screens—all construction would occur during the day. This impact would be less than significant. • Operation has a low potential to substantially degrade the visual character and quality of the surrounding area, as the screen would be in the water and adjacent to the river channel. Further, a structure for diversion purposes is already part of the visual character and quality and the screen would be located in the same place. Impacts would be less than significant.
Agriculture and Forestry Resources	• Construction and operation of fish screens would not be expected to be located on lands used for agriculture or forestry but within the footprint of existing river channels. There would be no conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use, conflict with existing zoning for agriculture use or a Williamson Act contract, conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Construction of fish screens would likely result in emissions associated with construction equipment and construction worker vehicle trips, as well as fugitive dust emissions from ground disturbance. The quantity, duration, and the intensity of construction activity may have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be “diluted” relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since construction of fish screens does not require lengthy construction activities, the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the SJVAPCD regulations and established thresholds. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • SJVAPCD generally defines a sensitive receptor as a facility that houses or attracts children, the elderly, people with illnesses, or others who are especially sensitive to the effects of air pollutants, and where there is a reasonable expectation of continuous human exposure according to the averaging period for National AAQSs (e.g., 24-hour, 8-hour, or 1-hour) (SJVAPCD 2002). Sensitive receptors are primarily concentrated in urbanized areas, and their

Potential Environmental Effects of Fish Passage Improvements—Fish Screens

Resource	Discussion
	proximity to construction or operational activities, the type of activity, and duration of activity, determines their potential exposure to pollutants. If criteria pollutant standards are exceeded during construction, and sensitive receptors are in proximity, mitigation measures identified in Table 16-38 would serve to reduce potentially significant air quality effects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, given the potential short term nature of construction and the required mitigation by the SJVAPC, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction of fish screens would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction of fish screens would not result in population or employment growth because these projects are intended only to benefit special-status fish species through improvement of fish passage. Therefore, construction of fish screens would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • Operation of fish screens would not result in direct emissions because they are passive structures. However, the fish screens would long-term operations and maintenance activities, which may include regular or periodic inspections, repairs, cleaning, and sediment and debris management to ensure the effectiveness of the screen over the design life of the facility, which would require maintenance vehicle trips. Because vehicle trips would be relatively limited in number, impacts on air quality and any sensitive receptors would be less than significant. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). Construction and operation of fish screens would not create objectionable odors affecting a substantial number of people. Impacts would not occur.
Biological Resources	• Construction of fish screens would release sediment and possibly hazardous materials (e.g., oil or fuel from construction equipment) into waterbodies, creating water quality issues. Release of sediment can bury macroinvertebrates, which are prey items for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat. Water quality measures such as monitoring turbidity to ensure compliance with Basin Plan water quality objectives and construction BMPs would be implemented. To ensure this, lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental

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	effects associated with construction of fish screens. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and installation of cofferdams can injure or kill fish, if cofferdams are needed, depending on the size of the diversion and the type and size of the screen. Pile driving can create noise impacts harmful to fish. Stranding within the cofferdams can occur if special-status fish species become trapped inside a dewatered area. Fish rescue in the dewatered area (seining, electrofishing) could injure or kill fish. These activities could result in take of special-status fish species. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction of fish screens. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even with mitigation measures, significant and unavoidable impacts may occur if the potential for take cannot be avoided or reduced or take occurs during construction. • Construction and operation of fish screens would be located in river reaches that support special-status fish species such as Chinook salmon and steelhead. These areas are expected to have high potential for special-status plant species, animal species, and habitat, and support biological resources. This could be a significant impact on special-status species and their habitats. It is reasonable to assume that construction of fish screens would occur during the least sensitive periods of special-status species life stages, (i.e., during the dry season, June–October), because this would reduce and minimize impacts on aquatic species and would be required through either the CEQA process or through permitting requirements and conditions by resource agencies including USFWS, CDFW, NMFS, Central Valley Water Board, and U.S. Army Corps of Engineers. As such, construction of fish screens would not interfere with the movement of native residential or migratory fish species and associated migratory corridors, or impede the use of nursery sites because any work done in the water would occur during June to October when fish are not spawning or migrating. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce potentially significant impacts on special-status biological resources from construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The surrounding habitat on river banks may include riparian vegetation and/or wetlands. Riparian vegetation may have to be removed to facilitate heavy equipment movement and wetlands may also be disturbed during construction activities. This would result in a temporary significant effect on riparian habitat and wetlands. Under operations, riparian habitat and wetlands would not be affected. Removal and/or disturbance of riparian and wetlands habitats would be compensated for at a ratio appropriate for the disturbance per standard permit requirements or conditions from the U.S. Army Corps of Engineers and Central Valley Water Board. This compensation would reduce and minimize impacts on fish and wildlife species and their habitats. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with

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Resource	Discussion
	construction of fish screens. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Operation of fish screens would change aquatic habitat by installing riprap near the intakes and changing velocity near the fish screen. Velocities will be measured at the screen to ensure they fall into the correct range for the fish species that will be present near the fish screen (CDFW 2016). Overall, the project may have beneficial long-term effects. Operation of fish screens would keep fish from entering agricultural fields or other areas of diversion, therefore increasing survival. This impact would be less than significant. • While construction may result in temporary localized adverse effects on special-status species, plants, and habitat, construction activities are highly unlikely to result in population level adverse effects for any species. As such, these activities are not expected to conflict with habitat conservation plans such as the SJR Wildlife Refuge CCP or the SJMSCP, which are meant to provide protection at the population level. In addition, conflicts with local policies as a result of construction would be less than significant because of the temporary and localized nature of the effects. Because fish screens are expected to produce beneficial results for special-status fish species, they would not conflict with local policies protecting biological resources or conflict with provisions of an adopted habitat conservation plan or natural community conservation plan, such as the SJR Wildlife Refuge CCP or the SJMSCP. This impact would be less than significant.
Cultural Resources	• Construction and operation of fish screens would be within existing river banks and channels at the location of existing diversions. River banks could be excavated for installation of structures during construction. It is unknown if cultural resources (significant historical, archaeological, or paleontological resources) or human remains exist in these locations. Typically the river channels have had high levels of disturbance because of hydraulic conditions and the fish screen sites would have been previously disturbed to install diversions. As such, there is a low potential for significant cultural resources to exist within the river banks. Operation of fish screens would have a very low potential to affect cultural resources because operation would be along the river bank and channels. It is reasonable to assume that where construction within areas that may contain cultural resources cannot be avoided, an assessment would be conducted of the potential for damage to cultural resources or human remains prior to construction. This may require hiring a qualified cultural resources specialist to determine the presence of significant cultural resources. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant effects on cultural resources associated with construction of fish screen projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.

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Geology and Soils	• The locations of new fish screens could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, construction or operation of fish screens would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. Impacts would not occur. • Construction would likely take place along rivers and in riparian areas where erosion can take place depending on the soil characteristics, geology, and area of disturbance. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant erosion or sediment effects associated with construction of fish screens. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 175091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Fish screens would not bring people to the risk of earthquakes or geologic hazards, meaning the operation of the areas would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur.
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-12, construction of fish screen projects would generate GHG emissions because heavy equipment would be used for a period of up to 6 months. While construction activities would be limited, it is likely that construction could result in a potentially significant GHG impact beyond SJVAPCD's ZEL. Depending on the level of construction activities and the potential operational lifespan of the project, construction-related GHG emissions could exceed these values and result in a potentially significant impact. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • During operation, some vehicles may be needed for monitoring or maintenance of the fish screens. However, the trips would be limited, of very short duration, and over a long period of time (e.g., one trip every year). As such, they would likely result in extremely small quantities of GHG emissions. However, GHG emissions may still exceed SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources.

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	○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Construction and operation of fish screens would not be a hazard or trigger safety concerns to public or public use airports or private airstrips because the structures would be constructed and operated within the river banks and channels and would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, construction and operation of fish screens would not result in a safety hazard for people residing or working in or near the project area. Impacts would not occur. • Construction and operation of fish screens would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road within the river banks and channels. Impacts would not occur. • Construction and operation of fish screens would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • Construction of fish screens could involve the temporary use of small amounts of hazardous materials, such as fuel to power construction equipment. There is a low potential for a hazardous materials spill associated with construction equipment given the limited duration of construction and the generally small number of construction equipment that would be used. However, since construction work would occur within river channels, Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due to hazards and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The precise location of fish screens would be constructed is not yet known; however, these projects could be constructed within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation activities. Table 16-39 lists potential

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	mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962. These sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the DTSC for Calaveras, Tuolumne, or Mariposa Counties (CalEPA 2016). There were a total of 17 sites identified for Merced, San Joaquin, and Stanislaus Counties. In addition to these sites identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 500 leaking underground storage tanks designated as open in these counties (CalEPA 2016). There are approximately 55 facilities in these counties that have received CDOs/CAOs not identified as non-hazardous wastes, domestic wastewater, or domestic sewage (CalEPA 2016). The active and open leaking underground storage tank cases and the CDO/CAO facilities are located throughout these counties. Although it is not yet known precisely where fish screens would be constructed, if construction were to occur on a Cortese Site, because construction activities would likely entail some ground disturbance (e.g., excavation), there would be potential for release of existing soil or groundwater contaminants. Were this to occur, impacts could be significant. Table 16-39 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • Construction of fish screens could require excavation. Utilities may be underneath the sites or adjacent to a site and may need to be relocated or avoided. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potential hazards associated with excavation around utilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.

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Resource	Discussion
Hydrology and Water Quality	• Construction of fish screens may temporarily affect hydrology and water quality due to grading along the river banks and channels. Turbidity resulting from construction activity on-bank and instream could cause a temporary exceedance of applicable water quality standards. Placing and anchoring the fish screens using pile driving or a crew in the water placing a screen, armoring the channel and banks with riprap and driving heavy equipment in and near the river channel could result in temporary turbidity. Due to the placement activities during the dry season, to avoid impacts on sensitive fish species, and isolation of the areas from surface water with cofferdams or some other means, it is expected that water quality impacts would be less than significant with mitigation incorporated. Turbidity should be monitored for Basin Plan objectives compliance during construction, reducing the impacts on water quality. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of fish screens would not deplete groundwater supplies or interfere substantially with groundwater recharge because these projects would not require groundwater supply and would not result in a substantial increase in impervious surfaces. Impacts would not occur. • Operation of the fish screens could alter the existing drainage pattern of the site or area but is not expected to cause an increase in substantial erosion or siltation, substantial runoff or result in flooding on- or offsite. Design would take into account existing hydrology and channel geomorphology and installation of the structures would be done so erosion or flooding would be controlled or would not occur. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of fish screens would not substantially increase the number of people exposed to the risk of flooding because these activities would not draw people to flood hazard locations. As such, construction and operation of fish screens would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Construction and operation of fish screens would not involve the construction of housing, and therefore this activity would not place housing within a 100-year flood hazard area. Impacts would not occur. • Construction and operation of fish screens would not impede or redirect flood flows because lead agencies would be required to comply with the requirements of USACE and the Central Valley Flood Protection Board to avoid increased flood potential. Impacts would be less than significant. • Construction of fish screens would not create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems because most activities would take place in the stream channel within a cofferdam. Impacts would not occur.

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Resource	Discussion
	• Operation of fish screens would not create or contribute runoff water or provide substantial additional source of polluted runoff. Most of the fish screen would be in the river channel, and although there may be some impervious surfaces on land associated with the screen it would not be expected to increase runoff volume or contribute polluted runoff. Maintenance of fish screens would be expected to be periodic would likely primarily entail cleaning the screens of debris from the river, which would not increase runoff volume or contribute polluted runoff. Impacts would not occur. • Construction of fish screens is not expected to provide substantial additional sources of polluted runoff because these activities would occur primarily within the stream channel. However, construction equipment would likely be working from the river bank and, as a result, hazardous materials (e.g., fuels, lubricants, diesel) would be used during construction. While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it result in a significant impact. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts on water quality associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction of fish screens is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of fish screens could result in a substantial degradation of water quality.
Land Use and Planning	• Construction and operation of fish screens would not physically divide an established community because they would be located within existing river banks and channels where communities are not established. Impacts would not occur. • Construction and operation of fish screens would occur in existing river banks and channels and would not conflict with land use designations or zoning because the activities would take place at an existing diversion already allowed by local policies or plans. In addition, these areas may be designated natural resource or open space areas by land use plans and fish screens would be consistent with those designations because they would enhance existing habitat for fish and wildlife species. Impacts would be less than significant. • The SJMSCP covers parts of the San Joaquin, Stanislaus, and Tuolumne Rivers. This plan protects special-status species within the San Joaquin, Stanislaus, and Tuolumne Rivers. As described in the Biological Resources section of this table, there could be some temporary construction impacts on adjacent riparian and/or wetland areas, but lead agencies would mitigate these temporary impacts through measures identified in Table 16-39. As such, no conflicts are expected with habitat conservation plans, natural community conservation plans, or other plans, policies, and

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Resource	Discussion
	regulations. Furthermore, the fish screens would help protect designated fish species that are identified within the habitat conservation plan as needing protection (e.g., splittail), and would ultimately support the purpose of the plan to protect these species. Impacts would be less than significant.
Mineral Resources	• Construction and operation of fish screens would not result in the removal or inability to access state or locally designated mineral resource areas. Fish screens would be located in areas that have already been modified by water diversions and there is a very low potential for mineral resources to exist. Impacts would not occur.
Noise	• Construction of fish screens would create noise related to the use of heavy construction equipment. The sites would be located within river banks and channels where people do not live. Of the 324 diversions that could be screened, the majority of them, 226, are located in areas with a population density of 0–100 people per square mile. Generally this would indicate they are located in fairly remote and sparsely populated areas, with a low likelihood of sensitive receptors to be located immediately adjacent to a project site. As such, for these diversions, it is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies due to the small nature of the projects and the remote location of these projects. Excessive ground-borne vibration or ground-borne noise levels are also not expected, unless pile driving is needed. If pile driving is needed it is not expected to cause excessive vibrations that would disturb sensitive receptors because of the remote location of the projects. Of the 324 diversions that could be screened, 104 are located in areas with a medium population density of 101–1,000 people per square mile and 2 are located in areas with a high population density of greater than 1,000 people per square mile. These are located in more urban areas and, as such, have a greater likelihood of having sensitive receptors located within relative close proximity to project site locations. As such, there may be temporary elevated noise in excess of standards established in local general plans, noise ordinance, or applicable standards that may affect sensitive receptors. These potential elevated noise levels would primarily occur during the day because construction is not expected to occur at night and for short periods of time within the day over a short duration (e.g., several weeks to several months, but generally less than 6 months). Given the potential for 106 locations to have sensitive receptors within relative close proximity, and the potential for pile driving, lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant effects associated with construction noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Operation of fish screens would not create noise. There may be some maintenance activities, but they would not create a permanent increase in ambient noise and impacts would be less than significant. • Projects would not be constructed near airports or airstrips so people would not be exposed to excessive noise levels. Impacts would not occur.

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Population and Housing	• The construction and operation of fish screens would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Furthermore, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • The construction and operation of fish screens would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the sites would be located within river banks and channels. No homes or people would be displaced. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, and other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, the construction and operation of fish screens would not involve an increase in population or housing. In addition, these actions would not include new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.
Recreation	• Construction of fish screens would occur within river banks and channels. It is possible that recreational facilities would be located in areas where fish screens would be constructed. If recreational facilities were located within very close proximity, construction of fish screens may affect them; however, it is unlikely that there would be significant impacts on recreational facilities because construction would be temporary and limited (e.g., several weeks to several months, but generally less than 6 months). Construction and operation of fish screens would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Construction of fish screens could result in some additional trips associated with construction workers. Depending on the location of the site, there could be an increase in traffic from construction workers. The temporary increased traffic during construction would likely not exceed local or regional road trip thresholds, because the number of construction workers that fish screen projects typically require is 5–10 people. This would be a less-than-significant impact. • Operation of fish screens would not generate additional trips beyond those needed to maintain the sites. If maintenance activities during operation are needed, they would be temporary in nature and would not affect traffic. Impacts would not occur. • Construction and operation of fish screens would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.

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Resource	Discussion
Utilities and Service Systems	• Construction and operation of fish screens would not exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of wastewater. Impacts would not occur. • Construction and operation of fish screens would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur. • The construction and operation of fish screens would not need the construction of additional storm water drains because the screens would be built within river channels and would not generate storm water. Impacts would not occur. • Construction and operation of fish screens would not generate an increase in solid waste because the activities would not generate large quantities of solid waste. Impacts would not occur. • Construction and operation of fish screens would not require a water supply. Impacts would not occur.

16.3.7 Fish Passage Improvements – Physical Barrier in the Southern Delta

Initiated by DWR in 1991, the South Delta Temporary Barriers Program (TBP) consists of seasonal installation of three rock barriers (Old River Near Tracy, Middle River, Grant Line Canal) designed to facilitate pumping by agricultural water diversions in the southern Delta, and a fourth barrier (Head of Old River [HOR]) designed to benefit SJR salmon and steelhead by improving attraction flows and passage conditions for adults in the fall, and survival of out-migrating smolts in the spring by blocking entry of smolts into Old River (See Section 16.4.5, *South Delta Temporary Barriers,* for more information regarding this program). Studies conducted by the Vernalis Adaptive Management Program (VAMP) demonstrated that increasing the volume of flow in the mainstem SJR and preventing smolts from entering Old River was effective in improving survival of SJR smolts through the Delta. Installation of the HOR barrier was prohibited in 2008 in response to a court order to protect delta smelt. In 2009 and 2010, USBR and DWR investigated the effectiveness of a non-physical barrier (bio-acoustic fish fence) in deterring juvenile salmonids from entering Old River. A permanent operable barrier at the HOR is currently proposed as part of the California WaterFix to prevent out-migrating salmonids from entering Old River in the spring and improve adult passage conditions and water quality (dissolved oxygen [DO]) in the SJR (particularly the Stockton Deep Water Ship Channel) in the fall. This section evaluates the construction and operation of a permanent operable barrier at HOR. It assumes the other temporary barriers under the TBP in the southern Delta would continue to be implemented as described in Section 16.4.5 as part of addressing the impacts of the CVP/SWP export operations on water levels and flow conditions that might affect salinity.

Cost Evaluation

DWR (2015a) produced a report in response to requirements of the NMFS 2009 Biological Opinion on the long-term operations of the CVP and SWP, discussing engineering solutions to reduce diversion of emigrating salmonids. This report discusses the potential engineering solutions for HOR and four other areas in the Delta. The HOR gate is estimated to cost $43,200,000 for construction and $200,000 for operation and maintenance.

Environmental Evaluation

The primary sources of information for the following description of physical barriers in the southern Delta and associated environmental impacts were NMFS's Biological Opinion for the 2012 South Delta Temporary Barriers Project (NMFS 2012), San Joaquin River Group Authority (SJRGA) Annual Technical Reports (2009, 2011), and the publicly available California WaterFix Draft Biological Assessment (USBR and DWR 2016).

Summary of Potential Action

As described in Section 16.4.5, *South Delta Temporary Barriers*, continued implementation of the TBP is currently part of baseline hydrologic, water quality, and biological conditions of the southern Delta. Because DWR would continue to work with the permitting and resource agencies to obtain the appropriate permits and conditions to operate the temporary barriers, there would be no change from baseline conditions or additional environmental assessment or regulatory requirements with future installation and operation of the temporary barriers. The barriers are typically installed in the spring and operated April–November. In general, installation of the barriers requires stockpiling of quarry rock on the waterside of the levee crown and use of heavy equipment (e.g., front loaders, dump trucks, excavators, cranes) to place the stockpiled rock and other structures (e.g., culverts, flashboard structures, concrete reinforcing mats) into the channel. As the rock barrier is extended into the channel, heavy equipment can use the top of the barrier to move farther into the channel to place additional material. Construction typically takes 1–3 weeks. The barriers are removed in the fall by reversing the installation procedure. The TBP includes a fish monitoring program employing the use of acoustic telemetry to assess the survival of salmon and steelhead with the south Delta barriers in place, and gain a better understanding of survival, migration behavior, and predator-prey interactions in the south Delta under various structural and operational water management conditions.

Foreseeable future barrier projects in the south Delta include the construction and operation of a permanent operable barrier at the HOR. The HOR is in San Joaquin County near the town of Lathrop. Currently proposed as part of the California WaterFix, the HOR gate would consist of five water control gates; a fish passage structure; a boat lock; and associated control, operations, and navigation facilities. Typical construction equipment for this type of project would include excavators, graders, cranes, pile drivers, bulldozers, dump trucks, and front-end loaders. The fish passage structure would be designed according to guidelines established by NMFS and USFWS. The barrier would be constructed with reinforced concrete within the confines of the existing channel with no levee relocation. To ensure stability of the levee, a sheet pile retaining wall would be installed in the levee where the operable barrier connects to it. Dredging of Old River and the placement of rock slope protection would be required upstream and downstream of the proposed structure. Cofferdams would be installed to create a dewatered area for construction of the foundation. Construction may last up to 3 years and may be conducted in two phases with half of the structure constructed in the first phase and the other half constructed in the second phase. A temporary work area would be established for storage and stockpiling of construction materials, fabrication of structural components, and construction of other temporary facilities and equipment. The operable barrier construction site, including the temporary work area, would be located in areas that were previously disturbed by construction and operation of the temporary rock barrier. Long-term operations and maintenance activities may include regular or periodic inspections, repairs, cleaning, and sediment and debris management to ensure the effectiveness of the barrier over the design life of the facility.

Potential Environmental Effects

Construction of the physical barrier in the southern Delta may result in temporary and localized effects typically associated with construction activities, including a change in water quality, air quality effects, and ground and channel disturbance. Placement of riprap and grading along the banks for the future HOR permanent barrier could change fish habitat in the area. Dredging would temporarily decrease macroinvertebrate density in the area of the barrier, resulting in a loss of prey for fish. Cofferdam placement and dewatering could result in special-status fish species becoming stranded within the cofferdam area. A rescue and relocation of all fish species would be needed within the isolated areas. The cofferdam and the rescue and relocation could result in injury or mortality of special-status fish species. Pile driving may be needed for structure and/or cofferdam installation. Noise levels could exceed injury/mortality ranges determined by NMFS and affect special-status fish species. Aquatic resources would likely be the most affected for a temporary period of time by the construction of the new HOR permanent operable barrier. Operation of the physical barrier could increase predation on juvenile special-status fish species (i.e., Chinook salmon and steelhead), but is also expected to benefit special-status fish species by directing them toward better migratory habitat. The new operable barrier would require maintenance. Maintenance would occur when needed and would include cleaning the barrier and regular or periodic inspections. Maintenance activities would be short term and not expected to have long-term effects on fish or other aquatic organisms.

It is reasonable to assume that the permanent physical barrier would be professionally installed by contractors familiar with such projects. Construction of the permanent barrier could last up to 3 years and may be conducted in two phases. Construction activities would occur during the dry season (typically June–October) when anadromous fish or other special-status fish species such as delta smelt would not be migrating or spawning. BMPs for controlling sediment and contaminant release into waterbodies would be used and minimize potential effects associated with water quality and hazardous materials. Mitigation measures to minimize stranding and protect against pile driving generated noise would be implemented. Operation of the permanent barrier would result in changes to hydraulics and aquatic habitats by the addition of riprap around the structure. They could also cause an increase in predation of special-status fish species due to the attraction of predatory fish to structures. Overall, operation of the barrier would help guide fish into better migratory habitat and increase survival. This is expected to benefit both special-status fish species and native fish species.

Table 16-21, *Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta*, summarizes the potential environmental effects associated with improving fish passage by use of a physical barrier in the southern Delta. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this non-flow measure and is referenced in Table 16-21 where appropriate.

Table 16-21. Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta	
Resource	Discussion
Aesthetics	• Construction and operation of a physical barrier would not be expected to significantly affect scenic vistas because it would be located at the current site of the TBP at HOR and there are no scenic vistas identified in the San Joaquin County general plan (San Joaquin County 2014a). Construction may be observable for a temporary period of time when heavy equipment is used to grade banks, move sediment, and install structures around the project site. Operation would have limited impacts on the aesthetics of the area as it would be similar to the temporary barrier that can already be viewed within the existing channel. The barrier would generally not be near residential or roadway areas so no sensitive receptors would be present if lighting was used during construction for a temporary period of time. Impacts would be less than significant.
Agriculture and Forestry Resources	• Construction and operation of physical barriers would not be expected to be located on lands used for agriculture or forestry but within the footprint of where the barrier is currently located (i.e., in Old River). Some temporary disturbance of area along the channel or behind the levee may be required for construction equipment and storage. However, there would be no permanent conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use, conflict with existing zoning for agriculture use or a Williamson Act contract, conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would be less than significant.
Air Quality	• Construction of physical barrier would likely result in emissions associated with construction equipment and construction worker vehicles, as well as fugitive dust emissions from ground disturbance. The quantity, duration, and the intensity of construction activities have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since construction of physical barriers wells does not require lengthy construction activities, (i.e., multiple years) the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the SJVAPCD regulations and established thresholds. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction of a physical barrier in the southern Delta would be inconsistent with applicable air quality plans or local general plans. A project is deemed

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta

Resource	Discussion
	inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction of a physical barrier in the southern Delta would not result in population or employment growth because this project is intended only to benefit special-status fish species through improvement of fish passage. Therefore, construction a physical barrier in the southern Delta would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • The physical barrier would operate passively and, as such, would not result in emissions. However, the barrier would require regular or periodic inspections and repairs, which would entail a limited number of maintenance personnel vehicle trips. Given the limited number of trips expected annually and the fact that they would be spread over time and be of short duration, this impact would be less than significant. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). Construction and operation of a physical barrier in the southern Delta would not create objectionable odors affecting a substantial number of people. Impacts would not occur.
Biological Resources	• Construction and operation of the physical barrier would be located in the Old River, which supports special-status fish species such as Chinook salmon and steelhead. This area is expected to have high potential for special-status plant species, animal species, and habitat, and support biological resources. It is reasonable to assume that in-water work of constructing the physical barrier would occur during the least sensitive periods of special-status species life stages, (i.e., during the dry season, June–October), because this would reduce and minimize impacts on aquatic species. As such, construction of the physical barrier would not interfere with the movement of native residential or migratory fish species and associated migratory corridors, or impede the use of nursery sites because any work done in the water would occur June–October when fish are not spawning or migrating. However, Table 16-39 lists potential mitigation measures the lead agency can and should implement to reduce potentially significant environmental effects of construction and operations on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Construction of the physical barrier would release sediment and possibly hazardous materials (e.g., oil or fuel from construction equipment) into waterbodies, affecting water quality. Release of sediment can bury macroinvertebrates which are prey for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat. Water quality measures such as monitoring turbidity to ensure compliance with Basin Plan water

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta

Resource	Discussion
	quality objectives and construction BMPs would be implemented. To ensure this, lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and installation of cofferdams can injure or kill fish by noise generated through pile driving and stranding, if special-status fish species become trapped inside a dewatered area. Pile driving can create noise impacts harmful to fish, resulting in injury or death. Fish rescue in the dewatered area (seining, electrofishing) could injure or kill fish. This would result in take and be a significant and unavoidable impact. Water quality measures such as monitoring turbidity to ensure compliance with Basin Plan water quality objectives and construction BMPs should be implemented per Table 16-39. Measures for reducing stranding and pile driving noise would also be followed. Furthermore, a monitoring plan assessing the movements of salmonids around the barriers would be enforced after the barriers are completed, which is part of permitting requirements and conditions by resource agencies (e.g., NMFS, Central Valley Water Board). Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction of the physical barrier. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even with mitigation measures, significant and unavoidable impacts may occur if the potential for take cannot be avoided or reduced or take occurs during construction. • Operation of the physical barrier would change aquatic habitat by installing riprap and changing hydraulics near the barrier. The change in hydraulic conditions would be assessed before construction to ensure velocities would not cause a change that would be detrimental to special-status fish species. The barrier itself could increase predation of juvenile salmonids by attracting predatory fish, but predation effects are unknown. Overall, the project would be expected to have beneficial long-term effects by guiding fish toward better migratory habitat. Operation of the physical barriers would keep fish from entering poor habitat and direct them toward better migratory and spawning habitat, therefore increasing survival. This impact would be less than significant. • The HOR permanent barrier would be constructed in the same area that has already been used for the temporary barriers so disturbance of riparian vegetation or wetlands is not anticipated. Additionally, this area has been continuously disturbed by installing and removing the temporary barriers. However, the lead agency can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction and operation of physical barriers. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta	
Resource	Discussion
	• While there is not specific language in either the SJMSCP or the SJR Wildlife Refuge CCP about barriers, these documents do identify that San Joaquin County would work with CDFW and other agencies to promote restoration for anadromous fish. The physical barrier is expected to produce beneficial results for migrating special-status fish species and, as such, construction and operation would not conflict with local policies protecting biological resources or conflict with provisions of an adopted habitat conservation plan or natural community conservation plans. Impacts would be less than significant.
Cultural Resources	• Construction and operation of the physical barrier would be within an area that has been regularly disturbed for the installation and removal of the temporary barrier. Because this area has been previously disturbed by the TBP installation, there is a low potential for significant cultural resources (significant historical, archaeological, or paleontological resources) and human remain presence. However, Table 16-39 lists potential mitigation measures the lead agency can and should implement to reduce potentially significant environmental effects of construction on cultural resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, its likely impacts could be mitigated to less than significant once mitigation measures were implemented given the low potential for cultural resources. • Operation of a permanent physical barrier would have a very low potential to affect cultural resources because operation would be in the same footprint as the TBP. This impact would be less than significant.
Geology and Soils	• Construction or operation of the barrier would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, loss of topsoil, or landslides. Impacts would not occur. • Given construction and operation would occur in close proximity to existing waterways and within a waterway, the proposed project site would be evaluated before construction begins for the potential of soil erosion under construction and operating conditions. Depending on soil conditions and the design and construction of the barrier, erosion could occur. The lead agency can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant erosion effects associated with construction and operation of the barrier. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The physical barrier would not bring people to the risk of earthquakes or geologic hazards, meaning the operation of the physical barriers would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur.

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta

Resource	Discussion
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-12, construction of the physical barrier would generate GHG emissions because heavy equipment would be used for a period of time over 3 years. While construction activities would be limited, it is likely that construction could result in a potentially significant GHG impact beyond the SJVAPCD's ZEL. Depending on the level of construction activities and the potential operational lifespan of the project, construction-related GHG emissions could exceed these values and result in a potentially significant impact. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • During operation of the barrier, vehicles may be needed for monitoring and maintenance. The trips are expected to be limited, of very short duration, and over a long period of time (e.g., one trip every year). As such, they would likely result in extremely small quantities of GHG emissions. However, GHG emissions may still exceed SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. • Adopt early action measures to reduce GHGs. • Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. • Adopt mandatory report rules for significant GHG sources. • Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. • Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs. • AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta

Resource	Discussion
Hazards and Hazardous Materials	• Construction and operation of the physical barrier would not be a hazard or provide a safety concern to public or public use airports or private airstrips because the structure would be constructed and operated within river banks and channels and would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, construction and operation of the physical barrier would not result in a safety hazard for people residing or working in the project area. Impacts would not occur. • Construction and operation of the physical barrier would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road within river banks and channels. Impacts would not occur. • Construction and operation of the physical barrier would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • Construction of in the physical barrier could involve the temporary use of small amounts of hazardous materials, such as fuel to power construction equipment. Given the in-water location of the barriers and the potential for a spill, this impact would be significant. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due to hazards and hazardous materials. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • There are no schools within one-quarter mile of the barrier. Therefore, there would be no hazardous materials impact on schools related to construction or operation of the HOR physical barrier. • The location at which the barrier would be constructed and operated is not a Cortese Site. Therefore, construction and operation of a physical barrier at this location would not create a significant hazard to the public or the environment. Impacts would not occur.
Hydrology and Water Quality	• Construction of the physical barrier may temporarily change water quality due to the placement of rock, dredging, and grading near and at the river's banks and channels. Turbidity resulting from construction activity on-bank and instream could cause a temporary exceedance of applicable water quality standards. Placing and anchoring the barrier structures and driving heavy equipment in and near the channel could result in a temporary increase in turbidity. Following the isolation of construction areas from surface water with cofferdams or other means, it is not expected that water quality standards will be violated. Turbidity should be monitored during construction for compliance with Basin Plan requirements, minimizing the potential impacts on water quality, per Table 16-39. Operation of the physical barriers would change the hydrology of the river and may also affect water quality (i.e., turbidity). It is likely water quality would be monitored when the HOR permanent barrier is operable. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta	
Resource	Discussion
	Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of the physical barrier would not deplete groundwater supplies or interfere substantially with groundwater recharge because this project would not require a water supply during construction or operation and would not result in a substantial increase in impervious surfaces. Impacts would not occur. • Operation of the physical barrier could alter the existing drainage pattern of the site or area but is not expected to cause an increase in substantial erosion or siltation, substantial runoff, or result in flooding on- or offsite. Site design would be modeled before installation and would take into account existing hydrology and channel geomorphology. Installation of the structure would be done so no erosion or flooding would occur. Table 16-39 lists potential mitigation measures that the lead agency can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Operation of the physical barrier would not create or contribute runoff water because the barrier would be within the river channel. Therefore, operations would not would exceed the capacity of existing or planned storm water drainage systems. Impacts would not occur. • Construction of the physical barrier is not expected to provide substantial additional sources of polluted runoff because these activities would occur primarily within the stream channel. However, construction equipment and construction vehicles would be working from the river bank and, as a result, hazardous materials (e.g., fuels, lubricants, diesel) may be used during this activity. While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it result in a significant impact. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts on water quality associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • Construction and operation of the physical barrier would not substantially increase the number of people exposed to the risk of flooding because these activities would not draw people to flood hazard locations. As such, construction and operation of the physical barrier would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur.

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta	
Resource	Discussion
	• Construction and operation of the physical barrier would not involve the construction of housing, and therefore this activity would not place housing within a 100-year flood hazard area. Impacts would not occur. • Construction and operation of the physical barrier would not impede or redirect flood flows within a 100-year flood hazard area. A physical barrier would be within the river channel and not built within the floodplain, i.e., not within the actual flood hazard area. Lead agencies would be required to comply with the requirements of USACE and the Central Valley Flood Protection Board to avoid increased flood potential. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction and operation of the physical barrier would not occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of the physical barrier could result in a substantial degradation of water quality.
Land Use and Planning	• Construction and operation of the physical barrier would not physically divide an established community because it would be located within existing river banks and channels where communities are not established. Impacts would not occur. • Operation of the physical barrier would occur in existing river banks and channels and would not conflict with land use designations or zoning. It would occur within the general area that the current temporary barrier is installed and removed. The zoning in the area is shown as water, with city limits of Lathrop on one side and general agriculture on the other side within the county limits, which provides for natural open space area. Construction laydown areas may result in a temporary disturbance to existing land uses and but would not result in a permanent change or conflict with existing land uses or zoning. Impacts would be less than significant. • No conflicts are expected with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations because the land use designation is general agriculture and associated support uses are natural open space and the barrier would support natural open spaces uses (San Joaquin County 2014b). Impacts would not occur.
Mineral Resources	• Construction and operation of the physical barrier would be constructed in an area previously used for this purpose. This area is not used to extract state or locally designated mineral resources. Therefore, construction and operation of permanent physical barrier would not affect state or locally designated mineral resources or result in the removal or inability to access state or locally designated mineral resource areas. Impacts would not occur.

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta

Resource	Discussion
Noise	• Construction of the physical barrier would create noise related to the use of construction heavy equipment. The site is located within river banks and channels where people do not live. It is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies due to the remote location of the project from populous areas. Excessive ground-borne vibration or ground-borne noise levels are also not expected, unless pile driving is needed. If pile driving is needed it is not expected to cause excessive vibrations that would disturb sensitive receptors because of the remote location of the project. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due construction noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the limited exposure of potential sensitive receptors to this potential temporary impact and low likelihood of potential sensitive receptors to exist because of the remoteness. • Operation of the physical barrier would not create noise. There would be maintenance activities required during operation, but they would not create a permanent increase in ambient noise. This impact would be less than significant. • The barrier would not be constructed near airports or airstrips so people would not be exposed to excessive noise levels. Impacts would not occur.
Population and Housing	• Construction and operation of the physical barrier would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Further, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • The construction and operation of the physical barrier would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the site is located within river banks and channels. No homes or people would be displaced. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, or other public facilities and schools) or the deterioration of existing public services typically results from an increase in population. As a location’s population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, the construction and operation of the physical barrier would not involve an increase in population or housing. In addition, these actions would not include new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.

Potential Environmental Effects of Fish Passage Improvements—Physical Barrier in the Southern Delta

Resource	Discussion
Recreation	• Construction of the physical barrier would occur within river banks and channels and block access to boaters in certain areas depending on the needs of construction, duration of construction, and timing of construction. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce effects on recreation during construction and operation of the barriers. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Construction and operation of the physical barrier would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Construction of the physical barrier could result in additional trips associated with construction workers. The location of the site is along existing levee roads away from major roadways so even with an increased number of trips, it is unlikely traffic would exceed existing level of service standards. Heavy construction equipment may damage dirt levee roads, so maintenance of the roads may be necessary during or after construction is complete. This impact would be less than significant. • Operation of the physical barrier would not generate additional trips beyond those needed to maintain the barrier. If maintenance activities are needed, it would be temporary in nature and would not increase traffic. Impacts would not occur. • Construction and operation of the physical barrier would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Construction and operation of the physical barrier would not exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of wastewater. Impacts would not occur. • Construction and operation of the physical barrier would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur. • Construction and operation of the physical barrier would not need the construction of additional storm water drains because the barrier would be built within the river and would not generate storm water. Impacts would not occur. • Construction and operation of the physical barrier would not generate an increase in solid waste because the proposed activities would not generate large quantities of solid waste. Impacts would not occur. • Construction and operation of the physical barrier would not require a water supply. Impacts would not occur.

16.3.8 Fish Passage Improvements – Removal or Modification to Human-Made Barriers to Fish Migration

Blockage of migration of anadromous fish to historical habitat by dams and other human-made barriers is recognized as a major reason for historical declines and current status of ESA-listed salmon, steelhead, and sturgeon in the Central Valley (Moyle and White 2002, Lindley et al. 2007, NMFS 2014a). In the SJR system, NMFS identified re-establishment of steelhead in historic habitat upstream of impassable mainstem dams as a Priority 1 recovery action on the Stanislaus, Tuolumne, and Merced Rivers (NMFS 2014a). Such actions present unique technological challenges that require extensive engineering, biological, and environmental studies to evaluate the feasibility of potential fish passage methods as well as the suitability and potential capacity of upstream habitat to support the life history and habitat needs of the target species. Conceptual alternatives for adult fish passage at dams include fishways, ladders, lifts and locks, and trap and haul operations (DWR 2013b). Feasibility studies of downstream passage alternatives for juveniles and post-spawning adults (steelhead) at large dams and reservoirs typically focus on methods for capturing downstream migrants above the reservoirs and transporting these fish to release sites below the dam.

Implementation of fish passage or re-introduction programs that restore passage of anadromous salmonids to reaches above impassable dams on the SJR tributaries would not likely occur within an effective timeframe to contribute to the State Water Board's implementation program or other non-flow measures that may be implemented in the foreseeable future to improve anadromous fish production in the currently accessible reaches below the dams (e.g., floodplain and riparian habitat restoration). Therefore, the following evaluation addresses only the pre-project planning and evaluation actions that would be required to support implementation of such a program in the future.

Cost Evaluation

The primary goal of a feasibility study is to demonstrate the project is economically viable if it is designed, constructed, and operated in accordance with the concepts set forth in the study. The cost of a feasibility study can be expected in the range of 1.5–4 percent of the project costs (Mackenzie and Cusworth 2007).

Environmental Evaluation

The primary source of information for the following summary of fish passage planning and evaluation actions was DWR (2007, 2013b).

Summary of Potential Action

Fish passage or re-introduction programs typically include pre-project engineering feasibility studies, fish passage and barrier assessments, hydrologic and water quality monitoring, habitat surveys and suitability assessments, environmental and economic analyses, and evaluations of the potential effectiveness of the program (measured in terms of achieving the biological goals of the program) based on the quantity and quality of potential habitat above the dams and other factors that could limit the success of the program. Based on these studies, an experimental or pilot re-introduction program may be recommended prior to implementation of any long-term re-introduction program.

Potential Environmental Effects

Pre-project planning, evaluation actions, and habitat assessments that would be required to support implementation of fish passage or re-introduction programs that restore passage of anadromous salmonids to reaches above impassable dams are not likely to result in any significant effects on special-status species or other resources (e.g., aesthetics, transportation, air quality). CEQA allows categorical exemptions for classes of projects which have been determined not to have a significant effect on the environment (Pub. Res. Code, § 21084). Specifically, information collection is exempt from CEQA review under a Class 6 categorical exemption. The Class 6 categorical exemption consists of basic data collection, research, experimental management, and resource evaluation activities which do not result in a major disturbance to an environmental resource. These may be strictly for information gathering purposes or as part of a study leading to an action which a public agency has not yet approved, adopted, or funded. (Pub. Res. Code, § 21084.) In addition, a Class 7 categorical exemption consists of actions taken by regulatory agencies to assume the maintenance, restoration, or enhancement of natural resources where the regulatory process involves procedures for protection of the environment. (Pub. Res. Code, § 21084.) Examples include, but are not limited to, wildlife preservation activities by CDFW. Construction activities are not included in a Class 7 categorical exemption and the types of evaluation and feasibility studies would not require construction. As such, many of the field studies involving fish passage and barrier assessments and hydrologic and water quality monitoring may be exempt under Class 6 or Class 7 categorical exemptions.

Access to river banks and channels is necessary for implementing the studies but would not result in effects on special-status species or their habitats because a crew of several people could do the surveys and the work would only cause a small disturbance for a limited period of time (e.g., several days to several weeks). Several persons would use one to two vehicles to access monitoring sites. Emissions from the vehicles would not conflict with an applicable air quality plan or violate air quality standards because there would be very few vehicles traveling during short periods of time. Water quality could be affected if activities included in-water work. However, it would be short term and only one or two persons would be in the river channel. The assessments would not alter the existing drainage pattern of the site or area or alter the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or offsite. There would be no impacts on traffic because the activities would require less than 10 people and vehicles. Other resources such as aesthetics, agriculture, and others would not be affected by field studies because the field studies would not alter or substantively change these types of resources when compared to existing conditions. It is reasonable to assume that field studies would be implemented or supervised by professional biologists who are familiar with such studies and projects. The biologists would recognize special-status aquatic and terrestrial species and avoid them if encountered during the field studies. These studies would provide the data to assess the possibility of introducing anadromous salmonids above impassable dams. As such, impacts on biological resources would be less than significant. The other studies such as pre-project engineering feasibility studies and suitability assessments, environmental and economic analyses, and evaluations of the potential effectiveness of the program (measured in terms of achieving the biological goals of the program), would be desk-top studies and based on data collected in the field.

16.3.9 Predatory Fish Control

The primary purpose of predatory fish control is to increase the survival of migrating salmonids and other native fishes through localized reductions of targeted predatory fishes and/or elimination or modification of habitat for predatory fishes at locations of high predation risk (*hotspots*). Predation by non-native striped bass, largemouth bass, and other warm-water species is identified as a major stressor for juvenile salmonids in the three eastside tributaries and mainstem LSJR (NMFS 2014a, McBain and Trush 2002, Brown 2000, FishBio 2013). Sites within the Delta that are currently considered hotspots of predator aggregation or activity, and which may contribute to high mortality rates of migrating smolts, include HOR, Old and Middle Rivers, Clifton Court Forebay, CVP intakes, and Georgiana Slough (Gingras 1997, Clark et al. 2009, Castillo et al. 2012, Bowen et al. 2009, Bowen and Bark 2010). Predation by non-native fishes has been identified as a likely contributor to low survival of Chinook salmon smolts in the interior Delta (Perry et al. 2010). In addition, considerable variability in smolt survival and an apparent shift in the relationship between smolt survival and flow in the southern Delta since 1997 (SJRGA 2009) suggests changes in biological factors such as predation (Hankin et al. 2010). However, a literature review of predation effects in the Delta by Grossman et al 2013, indicates that, "Although it is assumed that much of the short-term (<30 d) mortality experienced by these fish is likely due to predation, there are few data establishing this relationship. Juvenile salmon are clearly consumed by fish predators and several studies indicate that the population of predators is large enough to effectively consume all juvenile salmon production. However, given extensive flow modification, altered habitat conditions, native and non-native fish and avian predators, temperature and limitations, and overall reduction in historical salmon population size, it is not clear what proportion of juvenile mortality can be directly attributed to fish predation."

Acceptable strategies for predatory fish control include direct removal methods and habitat modifications to reduce predator habitat. Direct removal methods include electrofishing, hook-and-line fishing, passive trapping (e.g., fyke nets, hoop nets, gillnets), and active capture methods (e.g., trawls, beach seines). Habitat modifications that may reduce local aggregations of predators or their feeding efficiency include the removal or modification of abandoned structures (e.g., dams, bridge piers, docks), water diversion facilities (e.g., water intakes, forebays), scour holes, and invasive aquatic vegetation. Varying the location and/or timing of releases or routing of fish that are salvaged or bypassed at water intake or pumping facilities may also reduce predation losses associated with fixed release sites.

Cost Evaluation

As discussed above, predatory fish control can be accomplished through direct removal, or the elimination/modification of habitat conducive to predators. Using the method of direct removal of predators is generally less expensive than the elimination/modification of habitat as described below.

No long-term predator removal programs are in effect in the Delta; however, such programs have been implemented in rivers located in the western United States. For example, the Upper Colorado Endangered Fish Recovery Program (Recovery Program), established in 1988, is a partnership of local, state, and federal agencies, water and power interests, and environmental groups working to recover endangered fish in the Upper Colorado River Basin (Upper Colorado River Endangered Fish Recovery Program 2016). The Recovery Program implements long-term non-native fish management by removing the most problematic non-native fish predators from rivers. Among the non-native fish management projects funded within the Recovery Program are the middle Yampa River northern pike and smallmouth bass removal and evaluation project and the removal of smallmouth bass in the Upper Colorado River between Price-Stubb Dam near Palisade, Colorado, and Westwater, Utah project (Upper Colorado River Endangered Fish Recovery Program 2016). The total annual cost of each project from 2010 to 2015 was between $157,000 and $214,000[16] (Upper Colorado River Endangered Fish Recovery Program 2010a, 2011a, 2012a, 2013a, 2014a, and 2015a; Upper Colorado River Endangered Fish Recovery Program 2010b, 2011b, 2012b, 2013b, 2014b, and 2015b).

The costs of the habitat modification projects discussed above, designed to reduce predator habitat in the Delta and upstream tributaries, have been estimated as part of several recovery programs including: the Golden Gate Salmon Association Salmon Rebuilding Plan, the NMFS Final Recovery Plan (Recovery Plan)[17] (NMFS 2014a), the Habitat Restoration Plan for the Lower Tuolumne River Corridor (USFWS 2000), and the San Francisco Estuary Project 2007 Comprehensive Conservation and Management Plan (SFEP 2007). The various projects are site specific, and are dependent on the extent of the modifications needed and can vary in cost from $100,000–$300,000 per site for reducing predator habitat at large screen structures, to over $4.6 million for filling a gravel pit to reduce/eliminate habitat favored by predatory bass species, and replacing with high quality Chinook salmon habitat (McBain and Trush 2000, SFEP 2007, GGSA 2013, NMFS 2014a). On a broader scale, the Recovery Plan estimated implementing projects to minimize predation at weirs, diversions, and related structures in the Delta at $50 million over a period of 50 years[18] (NMFS 2014a).

Environmental Evaluation

Summary of Potential Action

Acceptable predator reduction methods likely would be limited to active and passive capture methods such as electrofishing, hook-and-line fishing, nets, and traps. These methods are preferred because they have no water quality impacts, minimal effects on non-target organisms, a higher degree of feasibility in open channel environments compared to other fish population control measures (e.g., chemical treatment, dewatering), and a lower level of risk of unintended ecological consequences. Limitations include high levels of effort and funding to achieve meaningful or measurable benefits, and significant uncertainty associated with the complexities of predator–prey interactions (e.g., compensatory responses by other piscivores) (Ward and Zimmerman 1999, Finlayson et al. 2010, Cavallo et al. 2012, also see Hubbs 1940 and other cited literature). Recreational reward fisheries using hook-and-line methods may be a relatively cost-effective means of reducing local predator densities and improving survival of migrating salmonids by concentrating intensive angling pressure on targeted predatory fish species at key location and times (Rieman and Beamsderfer 1990, Ward and Zimmerman 1999).

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[16] These costs are described in the Colorado River Recovery Program Annual Reports for 2010–2015.

[17] The National Marine Fisheries Service Final Recovery Plan targets the evolutionarily significant units of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and the distinct population segment of California Central Valley steelhead.

[18] This action originated from the Bay Delta Conservation Plan Administrative Draft (DWR 2013a), available: http://baydeltaconservationplan.com/Library/DocumentsLandingPage/BDCPDocuments.

Structural modifications aimed at reducing predator hotspots such as the removal or modification of human-made structures (e.g., removal of old pier pilings) and other forms of predator habitat (e.g., invasive aquatic vegetation) could result in effects on native fish and wildlife species, vegetation, soils, streambed substrates, and water quality. Structural modifications for predatory fish control do not include fish screen modifications which are discussed above in Section 16.3.6, *Fish Passage Improvements – Fish Screens*. The severity and magnitude of the impacts would vary depending on the timing, extent, and duration of these modifications; site conditions (e.g., presence of other sensitive resources); and the biological responses of individuals and populations to short- and long-term habitat changes. Potential construction activities include clearing of vegetation to construct temporary roads and staging areas; placement of temporary barriers or other structures to isolate active construction areas (e.g., cofferdams); and mechanical demolition, excavation, and extraction methods. Construction equipment may include excavators, hydraulic hammers, pile extractors, and cranes. Depending on the size of the structure to be removed or modified, construction could take between 6 months and 2 years. Common environmental commitments or BMPs to avoid, minimize, or offset potential construction-related effects may include seasonal work windows, preconstruction biological surveys; biological monitoring during construction; construction noise and light reduction measures; traffic control; SWPPP; spill prevention, control, and countermeasure plan; and turbidity compliance monitoring.

While there have been many studies determining the rate of predation on salmonids in the Central Valley and Delta (Clark et al. 2009, Garcia 1989, Gingras 1997, Holbrook et al 2009, Grossman et al 2013) the efficacy of predator control measures as an aid to rebuilding threatened and endangered salmonid populations and other native fish species remains unclear (Propst et al 2014, Grossman et al 2013). Recommended approaches to addressing these uncertainties and increasing the likelihood of desired outcomes include an experimental pilot program and an evaluation and refinement of the proposed measures.

Potential Environmental Effects

Active and passive capture methods are not expected to have significant impacts on aquatic or terrestrial sensitive-species habitat because the activities (hook-and-line fishing, nets, traps) would not modify habitat. However, if special-status fish species were caught with the active or passive capture methods, that could result in injury or mortality (i.e., *take*). Active and passive capture methods would harm individual non-native, predatory fish, because the purpose of the active and capture methods is to remove the predator fish once they are captured. Timing of the active or passive predatory control would vary depending on the species targeted and the design of the removal. It is reasonable to assume that active and passive capture methods would be done or supervised by professional fisheries biologists familiar with predatory fish and special-status species presence/absence in areas that would be fished.

CEQA allows categorical exemptions for classes of projects which have been determined not to have a significant effect on the environment. (Pub. Res. Code, § 21084.) Specifically, modification or demolition of existing structures can be exempt under a Class 1 categorical exemption. The Class 1 categorical exemption consists of the minor alteration of existing public or private structures, facilities, topographical features, involving negligible or no expansion of use beyond that existing at the time of the lead agency's determination. The types of "existing facilities" listed in the exemption are not intended to be all-inclusive of the types of projects which might fall within a Class 1 categorical exemption. The key to the consideration of this class of categorical exemptions is whether the project involves negligible or no expansion of an existing use. As structural modifications or removals for predatory control (e.g., removal of old pier pilings) would not expand an existing use, this type of predatory control may be eligible for a Class 1 categorical exemption depending on the project-specific circumstances. Structural modifications/removals of human-made structures could result in temporary and localized effects typically associated with construction activities, including water quality impacts and ground and channel disturbance. Depending on the size of the structure to be removed, placement of temporary barriers or other structures (e.g., cofferdams) may be required. This placement and dewatering could result in special-status fish species becoming stranded within the cofferdam area. A rescue and relocation of all fish species would be needed within the isolated areas if these types of construction activities are needed to remove structures. This could result in injury or mortality of special-status fish species. River banks or channels may need to be graded after removal of human-made structures in areas that support special-status fish species such as Chinook salmon and steelhead. Aquatic resources would be the most affected by structural modifications/removals. There would be no operation and maintenance activities for predatory fish control. For the structural modifications/removals, activities would be professionally done by contractors familiar with such projects. BMPs for controlling sediment and contaminant release into waterbodies would be used and minimize potential effects on water quality associated with sediment and hazardous materials. Mitigation measures to minimize stranding would be implemented.

Table 16-22, *Potential Environmental Effects of Predatory Fish Control*, summarizes the potential environmental effects associated with predatory fish control. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of this non-flow measure and is referenced in Table 16-22 where appropriate.

Table 16-22. Potential Environmental Effects of Predatory Fish Control

Potential Environmental Effects of Predatory Fish Control	
Resource	Discussion
Aesthetics	• Passive and active capture methods would not significantly affect scenic vistas because construction would not be required and because activities would be limited to people in the rivers passively or actively removing fish. This would not result in a permanent or even temporary alteration of river views. Impacts would not occur. • Removal or modification of human-made structures would be located within existing river channels and may alter views if the structure is located within a scenic vista or view. For modification/removal of a structure, construction may be observable for a temporary period of time when heavy equipment is used to grade banks, move sediment, and remove structures around the project site. This impact would be less than significant. • Lighting is not expected to be used during passive and active capture methods or removal of human-made structures—all activities would occur during the day. Impacts would not occur.
Agriculture and Forestry Resources	• Predatory fish control, both passive and active control and removal of structures, would not be expected to be located on lands used for agriculture or forestry but within existing river channels or immediately adjacent to them. There would be no conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use, conflict with existing zoning for agriculture use or a Williamson Act contract, conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Predatory fish control would likely result in emissions associated with the removal or modification of human-made structures which would involve construction equipment and construction worker truck trips, as well as fugitive dust emissions from ground disturbance. The quantity, duration, and the intensity of construction activities have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since removal of the structures would not require lengthy construction activities, the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the SJVAPCD regulations and established thresholds. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects on air quality associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean implementation of predatory fish control projects would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth

Potential Environmental Effects of Predatory Fish Control

Resource	Discussion
	estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The implementation of predatory fish control projects would not result in population or employment growth because these projects are for the benefit of special-status fish species through improvement of fish passage. Therefore, predatory fish control projects would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • Passive or active predator fish control or the removal of in-water structures, would likely result in monitoring vehicle trips on a periodic schedule. Given the limited number of vehicles over a longer timeframe, emissions from the vehicles would not prevent compliance with regulations or exceed thresholds established by SJVAPCD, conflict with or obstruct implementation of the applicable air quality plan, violate any air quality standard, contribute substantially to an existing or projected air quality violation, result in a net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standards, or create objectionable odors. Impacts would not occur.
Biological Resources	• Removal or modification of human-made structures would be located in river reaches that support special-status fish species such as Chinook salmon and steelhead. These areas are expected to have high potential for special-status plant species, animal species, and habitat, and support biological resources. It is reasonable to assume that removal or modification of human-made structures would occur during the least sensitive periods of special-status species life stages, (i.e., during the dry season, June–October), because this would reduce and minimize impacts on aquatic species. However, passive and active capture techniques could occur during any time of the year and this could result in interference with movement of native residential or migratory fish species and associated migratory corridors. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce potentially significant environmental effects of removal or modification of human-made structures and passive and active capture techniques on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Removal or modification of human-made structures would release sediment and possibly hazardous materials (e.g., oil or fuel from construction equipment) into waterbodies, potentially affecting water quality. Release of sediment can bury macroinvertebrates which are prey for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat. Water quality measures such as monitoring turbidity to ensure compliance with Basin Plan water quality objectives and construction BMPs would be implemented. To ensure this, lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with construction of fish screens. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section

Potential Environmental Effects of Predatory Fish Control

Resource	Discussion
	15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Depending on the type of structure and location of structure to be removed or modified, removal or modification of human-made structures could require installation of cofferdams. Cofferdams can injure or kill fish by noise generated through pile driving and stranding, if special-status fish species become trapped inside a dewatered area. Fish rescue in the dewatered area (e.g., seining, electrofishing) could injure or kill fish. Passive and active capture methods could capture special-status fish species if they are present in the targeted sampling area. These methods could injure or cause mortality of fish. As such, construction of cofferdams, and passive and active capture methods could result in take of special-status fish species. Removal of predatory fish is targeted toward removing non-native fish (e.g., striped bass, largemouth bass, smallmouth bass). If non-native predatory fish are captured, they would be removed and killed. It is anticipated that the removal may have localized effects, but would not overall reduce the population of the non-native fish given their general prevalence and resilience (Cavallo et al. 2012). Given the need for evaluation and refinement of predatory control programs, a monitoring program would be implemented to determine if survival is increased by the removal of predatory fish and to determine the effectiveness of the programs (Ward and Zimmerman 1999, Finlayson et al. 2010, Cavallo et al. 2012). Overall, the project may have temporary significant impacts during the removal or modification of human-made structures, but beneficial long-term effects by allowing fish to access more and better habitat and decreasing predation. Removal or modification of structures are not expected to have a substantial adverse effect, either directly or through habitat modifications, on special-status species. Measures for reducing stranding and pile driving noise would also be followed. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with removal or modification of human-made structures and passive and active capture methods. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Even with mitigation measures, significant and unavoidable impacts may occur if the potential for take cannot be avoided or reduced or take occurs during construction. • Passive capture methods would not result in disturbance or removal of riparian vegetation or wetlands as these methods would be implemented within existing river channels and would not temporarily or permanently remove habitat. No impact would occur.

Potential Environmental Effects of Predatory Fish Control	
Resource	Discussion
	• Removal or modification of human-made structures could affect riparian vegetation and/or wetlands. This is because the surrounding habitat on river banks may include riparian vegetation and/or wetlands. Riparian vegetation may have to be removed to facilitate heavy equipment movement and wetlands may also have to be disturbed during removal activities. This would result in a temporary significant impacts on riparian habitat and wetlands. Under operations, riparian habitat and wetlands would not be affected. Removal and/or disturbance of riparian and wetlands habitats would be compensated for at a ratio appropriate for the disturbance per standard permit requirements or conditions from the U.S. Army Corps of Engineers and the Central Valley Water Board. This compensation would reduce and minimize impacts on fish and wildlife species and their habitats. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with installation, removal, or modification of human-made structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The SJR NWR Comprehensive Conservation Plan includes activities that would benefit steelhead and Chinook salmon. It is unknown how effective the removal or modification of human-made structures are in reducing predatory fish and the potential benefits to special-status species. Overall, installation, removal, or modification of human-made structures to benefit special-status fish species would not conflict with local policies protecting biological resources or conflict with provisions of an adopted habitat conservation plan or natural community conservation plan. This would be a less-than-significant impact.
Cultural Resources	• Passive and active capture methods would not affect cultural resources (significant historical, archaeological, or paleontological resources) or human remains because they would not involve ground-disturbing activities or other construction activities that may disturb unknown cultural resources or human remains. Impacts would not occur. • Removal or modification of human-made structures would be within existing banks and channels or immediately adjacent. Typically river banks and channels have experienced a high level of disturbance as a result of hydrologic events and man-made alterations, resulting in a generally low likelihood of intact cultural resources or human remains. However, it is unknown if cultural resources or human remains exist in these locations, and river banks could be excavated for removal or modification of structures that contain unknown cultural resources or human remains. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on historic cultural resources during the removal or modification of existing structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • There would be no operational changes for either the removal or modification of the structures or passive and active capture methods and no ground-disturbing activity so there would be no impacts on cultural resources or human remains from operations. Impacts would not occur.

Potential Environmental Effects of Predatory Fish Control

Resource	Discussion
Geology and Soils	• Removal or modification of human-made structures and passive and active capture methods would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. Impacts would not occur. • The removal or modification of human-made structures and passive and active capture methods would not bring people to the risk of earthquakes or geologic hazards, and there would be no operational changes for the removal or modification of human-made structures and passive and active capture methods so they would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because the activities would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur.
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-12, removal or modification of human-made structures would result in increased GHG emissions because heavy construction equipment would be used. While construction activities would be limited, between 6 months and up to 2 years, it is likely that removal of structures could result in a potentially significant GHG impact beyond the SJVAPCD's ZEL. Depending on the level of construction activities and the potential operational lifespan of the project, construction-related GHG emissions could exceed these values and result in a potentially significant impact. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Passive and active control methods would not result in GHG emissions because there would be a very limited number of vehicles used to transport personnel to remove the predatory fish and the actions of removing the predatory fish do not produce GHGs. Some vehicles may also be needed for monitoring areas. However, the trips would be limited, of very short duration, and occur over a long period of time (e.g., one trip every year). As such, they would likely result in extremely small quantities of GHG emissions. However, GHG emissions may still exceed SJVAPCD's ZEL. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions.

Potential Environmental Effects of Predatory Fish Control

Resource	Discussion
	○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Passive and active capture methods would not be a hazard or provide a safety concern to public and public use airports or private airstrips because the structures would be removed or modified within river banks and channels and would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, passive and active capture methods would not result in a safety hazard for people residing or working in the project area. Impacts would not occur. • Removal or modification of human-made structures may release hazardous materials if the structures themselves contain hazardous materials (i.e., creosote pilings). It would be expected that any suspected structures would be tested prior to removal and disposed of in a proper facility. Additionally, fuel would be used in heavy equipment. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts associated with releasing hazardous materials by removing or modifying existing structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The precise location of where existing in-stream structures would be removed or modified is not yet known; however, these projects could be constructed within one-quarter mile (0.25 miles) of a school. Hazardous materials (e.g., fuels, lubricants, diesel) may be used during construction (i.e., grading near river banks and channels). While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction.

Potential Environmental Effects of Predatory Fish Control

Resource	Discussion
	• Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962. These sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the DTSC for Calaveras, Tuolumne, or Mariposa Counties (CalEPA 2016). There were a total of 17 sites identified for Merced, San Joaquin, and Stanislaus Counties. In addition to these sites identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 500 leaking underground storage tanks designated as open in these counties (CalEPA 2016). There are approximately 55 facilities in these counties that have received CDOs/CAOs not identified as non-hazardous wastes, domestic wastewater, or domestic sewage (CalEPA 2016). It is not yet known precisely where removal of or modification to structures would occur and removal or modification would require excavation. However, if it occurred on a Cortese Site and required excavation there would be potential for release of existing soil or groundwater contaminants because of the ground disturbance. Were this to occur, impacts could be significant. Table 16-39 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • Removal or modification of human-made structures and passive and active capture methods would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road within river banks and channels. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • Removal or modification of human-made structures could require excavation. Utilities may be underneath the sites or adjacent to a site and may need to be relocated or avoided. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potential hazards associated with excavation around utilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented.

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Resource	Discussion
Hydrology and Water Quality	• Removal or modification of human-made structures may temporarily affect water quality as a result of increased turbidity due to the removal of in-water structures and any grading near the banks and channels. Driving heavy equipment in and near the channel could result in temporary turbidity. Turbidity resulting from these activities could cause a temporary exceedance of applicable water quality standards. Due to the removal or modification activities limited to the dry season and isolation of the areas from surface water with cofferdams or some other means, significant impacts on water quality are not anticipated. Turbidity should be monitored during construction to ensure compliance with Basin Plan water quality objectives and construction BMPs would be implemented to minimize potential impacts on water quality. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Active capture methods could disturb substrate and potentially affect water quality depending on the method used. Active capture methods require people to enter the water and set up nets and then retrieve the nets. These methods can result in a slight disturbance of the substrate; however given the limited number of people that would be in the water and the limited ability of people to disturb substantial amounts of substrate impacts on water quality would be less than significant. • Removal or modification of human-made structures and passive and active capture methods would not deplete groundwater supplies or interfere substantially with groundwater recharge because these projects would not require groundwater and would not result in an increase in impervious surfaces. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not alter the existing drainage pattern of the site or area and are not expected to cause an increase in substantial erosion or siltation or result in flooding on- or offsite. This would be a less-than-significant impact. • Removal or modification of human-made structures and passive and active capture methods would not substantially increase the number of people exposed to the risk of flooding because these activities would not draw people to flood hazard locations. As such, predatory fish control would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not involve the construction of housing, and, therefore this activity would not place housing within a 100-year flood hazard area. Removal or modification of human-made structures and passive and active capture methods would not impede or redirect flood flows within a 100-year flood hazard area. Impacts would not occur. • Passive and active capture methods would not create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff because these activities would occur primarily within the stream channel. Impacts would not occur.

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Resource	Discussion
	• Removal or modification of human-made structures would not create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff because these activities would occur primarily within the stream channel. However, some grading near the banks and channels may be required and, as a result, hazardous materials (e.g., fuels, lubricants, diesel) may be used during this activity. While it is expected that these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it result in a significant impact. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts on water quality associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Removal or modification of human-made structures is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which predatory fish control projects could result in a substantial degradation of water quality.
Land Use and Planning	• Removal or modification of human-made structures and passive and active capture methods would not physically divide an established community because they would be located within existing river banks and channels, where communities are not established. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would occur in existing banks and channels and would not conflict with land use designations or zoning. Frequently these areas are designated natural resource or open space areas by land use plans and the removal or modification of human-made structures would be consistent with those designations because it would enhance existing habitat for fish and wildlife species. Impacts would not occur. • As discussed in the Biological Resources section of this table, no conflicts or changes with land use are expected due to the removal or modification of human-made structures or passive and active capture methods with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations. This impact would be less than significant.

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Resource	Discussion
Mineral Resources	• Passive and active control methods would not result in a loss or lack of access to a state or locally designated mineral resource because river channels would not be disturbed. Impacts would not occur. • Removal or modification of human-made structures would not have the potential to result in the removal or inability to access state or locally designated mineral resource areas. This is because the structures that would be removed or modified already exist and are either currently preventing access to a state or locally designated mineral resource or are not in the area of mineral resources. If these structures were removed, there may be the potential to access state or locally designated mineral resources when compared to current conditions. Impacts would not occur.
Noise	• Passive and active capture methods would not generate noise. Additionally, sensitive receptors would likely not be present in the area (i.e., in the middle of a river). Impacts would not occur. • Removal or modification of human-made structures would create noise related to the use of heavy construction equipment. The sites would be located within river banks and channels where people do not live. It is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies due to the small nature of the projects and the remote location of the project from populous areas. Excessive ground-borne vibration or ground-borne noise levels are also not expected unless pile driving is needed if a cofferdam needs to be put in place. If pile driving is needed it is not expected to cause excessive vibrations that would disturb sensitive receptors. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due construction noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the limited exposure of potential sensitive receptors to this potential temporary increase in noise and low likelihood of potential sensitive receptors to exist because of the remoteness. • Removal or modification of human-made structures and passive and active capture methods would not be done near airports or airstrips so people would not be exposed to excessive noise levels. Impacts would not occur.
Population and Housing	• Removal or modification of human-made structures and passive and active capture methods would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Furthermore, they would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the sites would be located within banks and channels. No homes or people would be displaced. Impacts would not occur.

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Resource	Discussion
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, removal or modification of human-made structures and passive and active capture methods would not involve an increase in population or housing. In addition, these actions would not include new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.
Recreation	• Removal or modification of human-made structures and passive and active capture methods would occur within river banks and channels. It is possible that recreational facilities would be located in areas where the human-made structures and passive and active capture methods would be located. If recreational facilities were located within very close proximity, removal or modification of human-made structures may affect them; however, it is unlikely that there would be significant effects on recreational facilities because removal or modification of structures and passive and active capture methods would be limited in scope and duration. This would be a less-than-significant impact. • Removal or modification of human-made structures and passive and active capture methods would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur. • Removal or modification of human-made structures and passive or active capture methods would likely target recreational and sport fish species, including striped bass. While it is unknown the number of fish that might be removed through predatory control, the removal of these species from the rivers could result in a reduction in recreational and sport fishing opportunities for fishermen. However, a few selected areas (i.e., below dams, areas where juvenile hatchery fish are released) would be targeted for predatory removal and they could easily move back into the area (Cavallo et al. 2012). It is highly unlikely to affect sport fish on a population level. This would be a less-than-significant impact.

Potential Environmental Effects of Predatory Fish Control	
Resource	Discussion
Transportation and Traffic	• Removal or modification of human-made structures could result in additional vehicle trips associated with construction workers. Depending on the location of the site, there could be an increase in traffic from construction workers. The temporary increased traffic during removal or modification would likely not exceed local or regional road trip thresholds, because the typical number of construction workers that would be involved in this activity is less than 30. Passive and active capture methods would require only a few people to perform the surveys so an increase in traffic is not expected. This impact would be less than significant. • There are no operational activities associated with either the removal or modification of human-made structures or passive and active capture methods so no additional trips would be generated. Impacts would not occur. • Removal or medication of human-made structures and passive or active capture methods would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Removal or modification of human-made structures and passive and active capture methods would not exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of wastewater. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not require the construction of additional storm water drains because the activities would occur within river channels and would not generate storm water. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not generate an increase in solid waste because they would limit modification to the river banks and channels and those activities do not generate large quantities of solid waste. Impacts would not occur. • Removal or modification of human-made structures and passive and active capture methods would not require a water supply. Impacts would not occur.

16.3.10 Invasive Aquatic Vegetation Control

Invasive aquatic vegetation control measures include actions to prevent the introduction and control the spread of invasive aquatic species. Invasive aquatic vegetation represents a major threat to native fish species because of its large-scale ecosystem effects on aquatic habitat and biological communities in the Delta and estuary (Toft et al. 2003, Baskerville-Bridges et al. 2004, Nobriga et al. 2005, Nobriga and Feyrer 2007, Anderson 2008, Santos et al. 2009, Hestir 2010, Huenemann et al. 2012). Current methods for control of Brazilian waterweed (*Egeria densa*), water hyacinth (*Eichhornia crassipes*), and other invasive plant species include small-scale and large-scale applications of herbicides and mechanical removal depending on the target species, site conditions, and objectives (DBW 2006, 2008). The primary goal of these programs is control rather than eradication because of the widespread distribution of these species. Relevant ongoing research includes investigations of potential biological control methods, and restoration design studies that provide useful insights into the natural properties of riverine and estuarine environments (e.g., flow velocity, salinity) that can be manipulated to reduce invasion risk (Hestir 2010).

Cost Evaluation

The California Department of Boating and Waterways (DBW) implements an Aquatic Weed Control Program, which includes a water hyacinth control program (WHCP). Established in 1982, the California state legislature designated DBW as the lead state agency to cooperate with other state, local, and federal agencies in controlling water hyacinth in the Delta, its tributaries, and Suisun Marsh (DBW 2016a). The WHCP uses chemical and physical control (mechanical and hand removal) as control methods for water hyacinth (DBW 2016b). The DBW also operates an *Egeria densa* control program (EDCP) that uses chemical control (DBW 2016b). The EDCP was authorized by law in 1997, and treatment began in 2001 (DBW 2016a). The total annual cost of DBW's Aquatic Weed Control Program (both the WHCP and EDCP) for the years of 2001 through 2007 was between $6.2 and $7.9 million dollars (DBW 2006, CDFW 2008). These programs are actively implemented today; however, cost information is only readily available through 2007.

Environmental Evaluation

The primary sources of information for the following general description of invasive aquatic vegetation control projects and associated environmental impacts were USDA and DBW (2012a, 2012b). Additional references are cited below.

Summary of Potential Action

General methods and techniques of invasive aquatic vegetation control programs include early detection and response; application of chemical, mechanical, or biological control methods; monitoring of treatment efficacy; and research and development of new control methods.

Chemical control (herbicide applications) is the most feasible and effective control method because herbicides can be used to rapidly control invasive aquatic plants over large areas (hundreds or thousands of acres). However, a major concern is the potential for toxic effects on other aquatic plants and animals and on riparian plants adjacent to treated waterbodies. All herbicides currently in use by DBW have been approved for aquatic use and are subject to permit restrictions on timing, application methods, and concentrations to avoid or minimize potential adverse effects on water quality and federally listed fish and wildlife species. An initial EIR was written and distributed in 2001 and an addendum was written in 2003 to incorporate the use of the aquatic herbicide Sonar Precision Release. The 2001 EIR proposed a 5-year program and one of the requirements of the EIR was to submit supplemental environmental documentation in 2006 to support continued operations. The second addendum written in 2006 discussed the environmental monitoring results. Currently, annual reports for *Egeria densa* and water hyacinth are submitted detailing the monitoring results of aquatic vegetation control. Permits from NMFS, USFWS, and the Central Valley Water Board are required every 5 years. Biological opinions from USFWS and NMFS are required under the federal Endangered Species Act (ESA) before herbicide application as well as a National Pollutant Discharge Elimination System (NPDES) permit from the Central Valley Water Board. These permits also require extensive water quality monitoring and toxicity research.

Physical control, which can be successful at relatively small scales, involves the removal of invasive aquatic vegetation by hand or machine and disposal on land. Machine removal requires a mechanical harvester that cuts and collects aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until ready for disposal. Removal and disposal of large amounts of aquatic vegetation can become prohibitive because of transportation costs and land requirements for disposal.

Biological control methods involve the release of organisms (typically invertebrates or pathogens that target invasive aquatic vegetation) into the environment with the goal of establishing sufficient numbers to reduce or limit the growth of the target species. Laboratory and limited field evaluations are underway to determine the efficacy of these organisms and the potential risk they pose to non-target species.

Implementation plans for invasive aquatic vegetation control programs will likely require compliance and effectiveness monitoring, research actions, and adaptive management.

Potential Environmental Effects

Invasive aquatic vegetation control programs could include early detection and response; application of chemical, mechanical, or biological control methods; monitoring of treatment efficacy; and research and development of new control methods. Application of chemical, mechanical, or biological control methods would result in effects on special-status fish species and existing aquatic habitat. Application of chemical controls would result in an effect on water quality and aquatic species if applied during the wrong time of year or concentrations are too high. Mechanical removal of aquatic vegetation would result in temporary and localized water quality effects including a change in water quality and ground and channel disturbance. Mechanical removal of certain species (e.g., *Egeria densa*) can also worsen infestations through dispersal and colonization by plant fragments. Small fish, invertebrates, amphibians, and turtles can be entrained and injured or killed. Also if the harvester is not properly disinfected, new exotic species could be introduced (Washington State Department of Ecology n.d.). Biological control methods, early detection and response to invasive aquatic species, and monitoring of treatment efficacy are not expected to affect special-status species because these methods would not involve herbicides, mechanical harvesters, or disturbance to waterbodies. Aquatic resources would be the most affected by invasive aquatic vegetation control programs because they are applied in the aquatic environment. Attempts to control aquatic invasive vegetation also can have a significant impact on the health and well-being of salmonids within the affected water systems. For example, the control programs for the invasive water hyacinth and Brazilian waterweed plants in the Delta must balance the toxicity of the herbicides applied to control the plants to the probability of exposure to listed salmonids during herbicide application. In addition, the control of the nuisance plants have certain physical parameters that must be accounted for in the treatment protocols, particularly the decrease in DO resulting from the decomposing vegetation left by plants that have died from the chosen control method (NMFS 2014a). After implementation of the invasive aquatic vegetation control programs, compliance monitoring, research actions, and adaptive management would be applied to the sites. This would require additional trips to the sites but are not expected to affect aquatic species or resources.

It is reasonable to assume that invasive aquatic vegetation control programs would be done by professionals that are familiar with control methods for invasive aquatic vegetation. It is likely that invasive aquatic vegetation would be targeted between June 1 and October 15 when anadromous fish or other special-status fish species would not be migrating or spawning. BMPs for controlling sediment and contaminant release into waterbodies would be used to minimize potential significant impacts on water quality associated with sediment and hazardous materials. Chemical spraying would be done and closely monitored by licensed professionals to ensure native aquatic species are not harmed. To determine if removing aquatic vegetation is successful, compliance monitoring, research actions, and adaptive management would be implemented.

Table 16-23, *Potential Environmental Effects of Invasive Aquatic Vegetation Control*, summarizes the potential environmental effects associated with invasive aquatic vegetation control.
Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, at the end of this chapter, lists potential mitigation measures associated with the construction and operation of this non-flow measure and is referenced in Table 16-23 where appropriate.

Table 16-23. Potential Environmental Effects of Invasive Aquatic Vegetation Control

Potential Environmental Effects of Invasive Aquatic Vegetation Control	
Resource	Discussion
Aesthetics	• Invasive aquatic vegetation control is not be expected to significantly affect scenic vistas because invasive aquatic vegetation removal may be observable for a temporary period of time if a mechanical harvester is used to extract aquatic plants at the project site. Operation would not affect the aesthetics of the area because compliance monitoring activities would be of short duration and would not change the aesthetics of a channel. However, removal of aquatic vegetation could change the visual character of a location because the aquatic vegetation would no longer be there to be viewed by sensitive receptors. While this is a change to visual character, it would likely not be significant as the existing channel would be restored to its previous open water condition. Lighting is not expected to be used during invasive aquatic vegetation control or monitoring—all activities would occur during the day. This impact would be less than significant.
Agriculture and Forestry Resources	• Invasive aquatic vegetation control is not be expected to be located on lands used for agriculture or forestry but within or adjacent to existing water channels. There would be no conversion of farmland (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural use, conflict with existing zoning for agriculture use or a Williamson Act contract, conflict with existing zoning of forest land, or conversion of forest land to non-forest use. Impacts would not occur.
Air Quality	• Removal of invasive aquatic vegetation would likely result in emissions associated with mechanical harvesters, disposal trucks, and worker vehicle trips. The quantity, duration, and the intensity of removal activities have an effect on the amount of emissions and related pollutant concentrations occurring at any one time. However, it is anticipated that, given the type of equipment that would be used and low level of activity associated with removal of aquatic vegetation, emissions would not likely prevent compliance with regulations or exceed thresholds established by SJVAPCD. In addition, activities would be required to implement measures to reduce or minimize removal-related emissions. Impacts would be less than significant. • General plan assumptions of local jurisdictions inform local air quality plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. Removal of invasive aquatic vegetation would not result in population or employment growth and therefore would not result in a conflict with or obstruct implementation of the applicable air quality plan because activities that are associated with population growth (e.g., housing development, business centers, etc.) would not be implemented as a result. Impacts would not occur. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing

Potential Environmental Effects of Invasive Aquatic Vegetation Control	
Resource	Discussion
	facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). Removal of invasive aquatic vegetation would not create objectionable odors affecting a substantial number of people. Impacts would not occur.
Biological Resources	• Invasive aquatic vegetation control could release sediment and possibly hazardous materials (e.g., oil or fuel from equipment and herbicides) into waterbodies, affecting water quality. Release of sediment can bury macroinvertebrates which are prey for fish and other aquatic species, coat or bury eggs from frogs and fish, and fill in pool habitat, and potentially temporarily interfere with the movement of native resident or migratory fish species and associated migratory corridors, and impede the use of nursery sites. Herbicides can kill aquatic plant species, and if the plants are not removed, decompose and decrease DO in the water. Overall, implementing invasive aquatic vegetation control may have temporary significant impacts during plant removal, but beneficial long-term effects by allowing fish to access more and better habitat, and decrease predation. Removal of invasive aquatic vegetation is not expected to have a substantial adverse effect, either directly or through habitat modifications on special-status species. Timing restrictions, water quality measures such as monitoring turbidity and chemicals during removal and other water quality BMPs should be followed. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with invasive aquatic vegetation control. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The surrounding habitat on river banks may include riparian vegetation and/or wetlands. Riparian vegetation may be removed to facilitate equipment movement and wetlands may also be disturbed during vegetation removal activities. This would result in a temporary significant impact on riparian habitat and wetlands. Under operations, riparian habitat and wetlands would not be affected. Permanent removal and/or disturbance of riparian and wetlands habitats would be compensated for at a ratio appropriate for the disturbance per standard permit requirements or conditions from the U.S. Army Corps of Engineers, the Central Valley Water Board, and other conditioning agencies. This compensation would reduce and minimize impacts on fish and wildlife species and their habitats. Lead agencies can and should implement potential mitigation measures identified in Table 16-39 to reduce potentially significant environmental effects associated with implementing invasive aquatic vegetation removal projects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Invasive aquatic vegetation control would be conducted in channel reaches that support special-status fish species such as Chinook salmon and steelhead. These areas are expected to support biological resources. It is reasonable to assume that invasive aquatic vegetation control would occur during the least sensitive periods of special-status species life stages, (i.e., between June 1 and October 15), because this would reduce and minimize impacts on aquatic species. Table 16-39 lists potential mitigation measures lead agencies can and should implement to reduce

Potential Environmental Effects of Invasive Aquatic Vegetation Control

Resource	Discussion
	potentially significant environmental effects of invasive aquatic vegetation control on special-status biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Because invasive aquatic vegetation control is expected to produce beneficial results for special-status fish species, this activity would not conflict with local policies protecting biological resources or conflict with provisions of an adopted habitat conservation plan or natural community conservation plan. Impacts would be less than significant.
Cultural Resources	• Invasive aquatic vegetation control and compliance monitoring would not involve limited ground-disturbing activities to set up equipment adjacent to channels and therefore would have a very low potential for disturbing any unknown existing cultural resources (significant historical, archaeological, or paleontological resources) or human remains. Impacts would be less than significant.
Geology and Soils	• Invasive aquatic vegetation control would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, soil erosion, loss of topsoil, or landslides. No impact would occur. • Invasive aquatic vegetation control would not bring people to the risk of earthquakes or geologic hazards, and compliance monitoring would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because the activities would not draw people to earthquake areas or hazard locations not already frequented. No impact would occur.
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-12, invasive aquatic vegetation control would result in increased GHG emissions because heavy construction equipment would be used. Given the limited duration of removal activities (up to 1 week) and limited amount of equipment associated with invasive aquatic vegetation control, these activities would likely not exceed the SJVAPCD's ZEL. During compliance monitoring, trips would be by vehicle and of very short duration over a long period of time and would likely result in extremely small quantities of GHG emissions. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources.

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Resource	Discussion
	○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Invasive aquatic vegetation control would not be a hazard or provide a safety concern to public and public use airports or private airstrips because it would not involve structures that could impede, interfere, or otherwise create a safety hazard to airports or air traffic. As such, invasive aquatic vegetation control would not result in a safety hazard for people residing or working in the project area. Impacts would not occur. • Invasive aquatic vegetation control would not physically interfere with an adopted emergency response plan or emergency evacuation plan because the sites would be located off-road within river banks and channels. Impacts would not occur. • Invasive aquatic vegetation control would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur. • As discussed in the Biological Resources section of this table, there are specific regulations regarding spraying of herbicides for controlling aquatic vegetation. Table 16-39 in the Biological Resources section, discusses mitigation measures that minimize impacts from herbicide application. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • The precise location(s) of where aquatic vegetation control would occur is not yet known; however, this activity could occur within one-quarter mile (0.25 miles) of a school. Hazardous materials (i.e., herbicides) may be used to control aquatic vegetation. While it is expected herbicides would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Table 16-39 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to that minimize impacts from herbicide application. Until such time that these potential mitigation measures are implemented, the

Potential Environmental Effects of Invasive Aquatic Vegetation Control	
Resource	Discussion
	impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented. • Aquatic vegetation control could entail limited ground disturbing activities (e.g., grading, excavation) in some circumstances, depending on the vegetation being controlled and the type of control mechanism selected. Lists of hazardous materials site are compiled by different state agencies under Government Code, § 65962. These sites are also known as Cortese Sites. There were no sites identified on the Hazardous Waste and Substance Site List compiled into the EnviroStor online database managed by the DTSC for Calaveras, Tuolumne, or Mariposa Counties (CalEPA 2016). There were a total of 17 sites identified for Merced, San Joaquin, and Stanislaus Counties. In addition to these sites identified by the EnviroStor database, CalEPA also identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facilities where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action for these counties (CalEPA 2016). There are approximately 500 leaking underground storage tanks designated as open in these counties (CalEPA 2016). There are approximately 55 facilities in these counties that have received CDOs/CAOs not identified as non-hazardous wastes, domestic wastewater, or domestic sewage (CalEPA 2016). It is not yet known precisely where invasive aquatic vegetation control would occur and removal would require excavation or ground disturbing activities. However, if it occurred on a Cortese Site and required excavation there would be potential for release of existing soil or groundwater contaminants because of the ground disturbance. Were this to occur, impacts could be significant. Table 16-39 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed.
Hydrology and Water Quality	• Invasive aquatic vegetation control may temporarily affect water quality due to the mechanical removal of aquatic plants within an active channel. Mechanical removal involves using a harvester and the harvester can hit the substrate and increase surface water turbidity. If aquatic vegetation is controlled with herbicides, water quality would be affected and water quality standards could potentially be violated. As a result, aquatic species including fish and invertebrates could be adversely affected. This is a significant impact. The DBW is the only agency authorized to use herbicides on invasive aquatic vegetation and they must receive biological opinions from USFWS and NMFS before applying herbicides. In addition, the Central Valley Water Board requires compliance with a statewide NPDES permit for residual aquatic pesticide discharges to surface waters from aquatic vegetation control application. The two biological opinions (USFWS and NMFS) and the NPDES permit requires a water monitoring program which involves a minimum of 10 percent of all treatment sites be sampled to collect and analyze Delta water quality data, and results of chemical residue and toxicity tests after applying herbicides (DBW 2009). Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts on water quality. Until such time that these potential mitigation measures are implemented, the

Potential Environmental Effects of Invasive Aquatic Vegetation Control	
Resource	Discussion
	impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Invasive aquatic vegetation control would not deplete groundwater supplies or interfere substantially with groundwater recharge because these projects would not require groundwater and would not result in an increase in impervious surfaces. Impacts would not occur. • Invasive aquatic vegetation control would not alter the existing drainage pattern of the site or area and is not expected to cause an increase in substantial erosion or siltation or result in flooding on- or offsite. Impacts would not occur. • Invasive aquatic vegetation control would not substantially increase the number of people exposed to the risk of flooding because these activities would not draw people to flood hazard locations. As such, Invasive aquatic vegetation control would not expose people to significant loss, injury, or death related to flooding. Impacts would not occur. • Invasive aquatic vegetation control would entail the application of chemical, mechanical, or biological control methods. Accordingly, this activity would not place housing within a 100-year flood hazard area or impede or redirect flood flows within a 100-year flood hazard area. Impacts would not occur. • Invasive aquatic vegetation control would not create or contribute runoff water, and therefore this activity would not exceed the capacity of existing or planned storm water drainage system. Impacts would not occur. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Invasive aquatic vegetation control is not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which aquatic vegetation control projects could result in a substantial degradation of water quality.
Land Use and Planning	• Invasive aquatic vegetation control would not physically divide an established community because aquatic plants would be located within existing river banks and channels where communities are not established. Impacts would not occur. • Invasive aquatic vegetation control would occur in existing river banks and channels and would not conflict with land use designations or zoning. Frequently these areas are designated natural resource or open space areas by land use plans and the removal of aquatic vegetation would be consistent with those designations because it would enhance existing habitat for fish and wildlife species. Impacts would not occur. • No conflicts are expected with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations. Impacts would not occur.

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Resource	Discussion
Mineral Resources	• Invasive aquatic vegetation control would not result in the removal or inability to access state or locally designated mineral resource areas. This is because the removal of aquatic species would not involve activities that would limit access to or remove important locally or state designated mineral areas. Impacts would not occur.
Noise	• Invasive aquatic vegetation control would create noise related to the use of a mechanical harvester. However, the sites would be located within river banks and channels where people do not reside. It is unlikely people would be permanently exposed to noise levels in excess of standards established in the local general plan, noise ordinance, or applicable standards of other agencies due to the small nature of the projects and the remote location of the project from highly populated areas. Excessive ground-borne vibration or ground-borne noise levels are also not expected due to the type of equipment that would be used for mechanical or herbicide removal activities. While there may be temporary elevated noise in excess of standards established in local general plans, noise ordinance, or applicable standards, it would occur during the day because vegetation control activities are not expected to occur at night. Table 16-39 lists potential mitigation measures that lead agencies can and should implement to reduce potentially significant impacts due construction noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the limited exposure of potential sensitive receptors to this temporary noise increase and low likelihood of potential sensitive receptors to exist because of the remoteness. • Compliance monitoring would not create noise because only a few people would be performing the monitoring and sensitive receptors would not be present in the area. • Invasive aquatic vegetation control would not be done near airports or airstrips so people would not be exposed to excessive noise levels. Impacts would not occur.
Population and Housing	• Invasive aquatic vegetation control would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Furthermore, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people. Impacts would not occur. • Invasive aquatic vegetation control would not displace substantial numbers of people or existing housing or necessitate the construction of replacement housing elsewhere because the sites would be located within river banks and channels. No homes or people would be displaced. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, libraries, parks, schools, or other public facilities) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. Invasive aquatic vegetation control would not involve an increase in population or housing. In addition, these actions would not include proposals for new housing and would not generate students or increase demands for school services or facilities. Impacts would not occur.

Potential Environmental Effects of Invasive Aquatic Vegetation Control

Resource	Discussion
Recreation	• Invasive aquatic vegetation control would occur within river banks and channels. It is possible that areas may be temporarily restricted for recreational activities during primary application of chemicals or during mechanical removal; however, access would be restored and as such, significant effects on recreational facilities are not expected. Removal of thick aquatic vegetation may allow increased boat access to areas that previously were not accessible. Compliance monitoring would not affect recreational facilities because only a few people would be involved in the monitoring activities. This would be a less-than-significant impact. • Invasive aquatic vegetation control would not increase the use of existing parks or recreational facilities and would not result in the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Invasive aquatic vegetation control could result in a very few limited additional vehicle trips associated with workers. Depending on the location of the site, there could be a slight increase in traffic from workers. The temporary increase in traffic during aquatic vegetation control activities would likely not exceed local or regional road trip thresholds, because the number of workers that would be involved in these activities is less than 30. This would be a less-than-significant impact. • Invasive aquatic vegetation control would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Invasive aquatic vegetation control would not exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of wastewater. Impacts would not occur. • Invasive aquatic vegetation control would not involve construction or expansion of new or existing wastewater treatment facilities or water treatment facilities. Impacts would not occur. • Invasive aquatic vegetation control would not need the construction of additional storm water drains because the activity would occur within river channels and would not generate storm water. Impacts would not occur. • Invasive aquatic vegetation control would not generate an increase in solid waste because it involves activities that do not generate large quantities of solid waste. Impacts would not occur. • Invasive aquatic vegetation control activities would not require a water supply. Impacts would not occur.

16.4 Southern Delta Water Quality Alternatives – Reasonably Foreseeable Methods of Compliance

To achieve compliance with the numeric salinity objectives identified in the SDWQ alternatives, the Central Valley Water Board, in adopting or amending NPDES permits for point-source dischargers into the southern Delta (e.g., WWTPs), would have to implement the numeric objective (e.g., 1.0 deciSiemens per meter [dS/m] or 1.4 dS/m). This means that WWTPs with discharges that have a reasonable potential to cause or contribute to an excursion above the numeric objective would have effluent limitations in their NPDES permits to meet the revised objective.[19] In Chapter 13, *Service Providers*, it was identified that under SDWQ Alternative 2, the Cities of Tracy and Stockton, and Mountain House CSD may need to implement changes to their facilities. The regulated community (e.g., service providers of wastewater treatment services) who cannot comply with the revised effluent limitations may seek and obtain a variance for up to 10 years pursuant to Central Valley Water Board Resolution R5-2014-0074, which has the effect of delaying compliance. Ultimately, however, these service providers would have to comply and may choose to do one or a combination of actions to achieve compliance with potential NPDES permit changes as a result of the SDWQ alternatives. The reasonably foreseeable methods of compliance that service providers may take to comply with salinity requirements of SDWQ Alternative 2 are:

- Developing new source water supplies such that they have less salt
- Implementing salinity pretreatment programs that require CII facilities or residential salinity source controls, which would reduce the amount of salts that are discharged to the sewer system
- Implementing an effluent desalination process at the WWTP before treated effluent is discharged to the southern Delta

In addition, the Central Valley Water Board could adopt, revise or reissue waste discharge requirements (WDRs) or it could use the Irrigated Lands Program to require compliance with either SDWQ Alternative 2 or 3. As such, implementing salinity removal through agricultural return salinity control is considered a method of compliance.

Under the program of implementation for SDWQ Alternative 2 or 3, continued operations of the agricultural barriers at Grant Line Canal, Middle River, and Old River at Tracy, could occur to address the impacts of the CVP or SWP export operations on water levels and flow conditions that might affect salinity. This analysis assumes the existing temporary barriers would likely continue to operate in the southern Delta under the program of implementation because DWR determined it is essential to continue barrier installations to protect salmon migrating through the Delta, and to provide an adequate agricultural water supply for southern Delta farmers. The program of implementation for both SDWQ Alternatives 2 and 3 also requires additional studies and monitoring of the southern Delta circulation and water levels. It is possible that additional studying and monitoring would determine the need for modifications of the temporary barriers. If this

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[19] Municipal WWTPs in the southern Delta are currently not subject to the existing numeric objective as a result of a superior court decision in *City of Tracy v. California State Water Resources Control Board*, Sacramento Superior Court, Case No. 34-2009-80000392.

determination is made by the State Water Board, DWR may be required to install low lift pumping stations at the temporary barriers as a method of compliance.

The regulated community (e.g., agriculture users or DWR) may choose to do one or a combination of many actions to achieve compliance related to either a reissuance of WDRs or the Irrigated Lands Program and the program of implementation. As such, the reasonably foreseeable methods of compliance for SDWQ Alternatives 2 and 3 are:

- Implementing salinity removal through agricultural return flow salinity control before treated effluent is discharged to the southern Delta
- Continuation of temporary barriers program
- Implementing low lift pumping stations in the southern Delta

The cost and environmental impacts of the actions associated with the methods of compliance that service providers, agricultural users, and DWR may implement are evaluated below. It should be noted that the regulated community could implement one or more than one of the methods of compliance evaluated. Because it is unknown which members of the regulated community would decide on which method(s) of compliance, for the purposes of this discussion, the methods of compliance are analyzed separately.

16.4.1 New Source Water Supplies

Water supplies with high salinity content can contribute to elevated salinity discharges to the southern Delta. Generally, water purveyors in the plan area (e.g., the Cities of Tracy and Stockton) rely on a combination of surface water and groundwater to meet potable water demand. Groundwater is typically more saline than surface water in the San Joaquin Basin.

Cost Evaluation

One method to reduce salinity discharges is to use more high-quality water (i.e., surface water) to meet water demands. To use more surface water, a water purveyor may need to enlarge existing structures (water intake, treatment facility, pipelines, and pumps), or build new structures.

One comparable project is the Davis-Woodland Water Supply Project (DWWSP). The DWWSP will construct a surface water intake, water treatment plant, pump stations, storage tanks, and associated transmission lines to develop 45,000 AF/y of new, high quality water from the Sacramento River. The DWWSP is in the construction phase, which began in April 2014, and is estimated to be completed in September 2016. The estimated project costs are detailed in Table 16-24, *Design and Construction Costs for the Davis-Woodland Water Supply Project and Delta Water Supply Project*.

The City of Stockton has completed its Delta Water Supply Project (DWSP) which will divert water pursuant to Water Code Section 1485. Water Code Section 1485 allows any municipality disposing of treated wastewater into the SJR to seek a water right to divert a like amount of water, less losses, from the river downstream of the point of its wastewater discharge. The DWSP will develop 33,600 AF/y of new water resources in the Delta. The DWSP has completed construction of a new surface water intake, water treatment plant, pump stations, and pipelines. The estimated project costs are also detailed in Table 16-24, *Design and Construction Costs for the Davis-Woodland Water Supply Project and Delta Water Supply Project*.

Table 16-24. Design and Construction Costs for the Davis-Woodland Water Supply Project and Delta Water Supply Project

Cost Category	DWWSP (millions)	DWSP (millions)
Design and Construct Intake	$15.6	$22.3
Design and Construct Treatment Facilities and Pipelines	$236.9	$176.6
Project Administration[a]	$33.1	$14.2
Other Local Costs[b]	$51.4	$21.6
Total	$337.0	$234.7

Sources: Woodland-Davis Clean Water Agency 2011; Price pers. comm.

Note: All costs are in in 2010 dollars.

DWWSP = Davis-Woodland Water Supply Project.

DWSP = Delta Water Supply Project.

[a] Project Administration includes environmental and construction permitting, land acquisitions, rights of way, pre-design, agency administration and contingency, program management, water rights permits, and water supply acquisition.

[b] Other Local Costs includes costs to the water purveyor not included in the project, but necessary to integrate the project into the existing infrastructure.

Based on information available for these two projects, it could cost $234.7–$337 million to plan, design, manage, and construct the required facilities to develop 33,600–45,000 AF/y of new surface water resources in the Delta.

Environmental Evaluation

Summary of Potential Action

Procuring and providing alternate low-salinity water source(s) to water users in a service area would reduce the salinity in the potable water used, ultimately lowering the salinity in the wastewater and treated effluent discharged from the WWTP. This action would require municipalities and/or water districts that serve customers in the southern Delta to obtain a new source of low-salinity water (e.g., purchasing surface water diversions from senior surface water users) and would likely require modifications to existing water supply distribution system(s) or the construction and operation of new water supply distribution system(s). The water supply distribution system(s) would take the new source of low-salinity water and distribute it within the water district service area. Municipalities and/or water districts with service areas within the southern Delta or that provide water to customers who ultimately discharge treated effluent into the southern Delta and could implement changes to their distribution system(s) include: City of Tracy, Mountain House CSD, and City of Stockton. These municipalities provide both water supply and wastewater treatment services.

The location, timing of construction, details of operation, and source of low-salinity water are all unknown. In addition, the size and scale of the facilities is unknown. These unknown factors would influence the type, magnitude and severity of impacts that could occur during construction and operation. It is expected that obtaining an alternative source of low-salinity water would require the construction and operation of underground pipelines and/or above-ground canals and pump stations to distribute water from one unknown location to another. Underground pipes would be typically located within existing road rights-of-way, adjacent to existing utility lines and approximately 3–8 ft below ground surface. If canals were to be used, the location and number of canals are unknown. If pump stations are used, they would likely be located adjacent to the canals or the pipelines, but the locations are unknown.

Potential Environmental Effects

Construction of new source water supply facilities would likely result in temporary and highly localized effects typically associated with similar construction activities, such as air quality effects and ground disturbance. As noted above, it is likely that such facilities would be constructed in areas that are already disturbed by urban development, and most facilities would be located within existing facility footprints and road rights-of-way. Depending on the precise location, new diversion facilities could have the potential to affect aquatic resources during construction and operation, which would need to be evaluated and mitigated as part of the project level analysis. Construction and operation of such facilities are highly regulated, and the project would be required to comply with applicable regulations. In addition, because such facilities are owned by water supply purveyors and service districts or WWTP service districts[20] and subject to CEQA review, any new projects would undergo project-level analysis under CEQA and other required regulatory compliance at the time they are proposed. Implementation of these potential methods of compliance would improve salinity conditions in the southern Delta.

Table 16-25, *Potential Environmental Effects of New Source Water Supply Facilities*, summarizes the potential environmental effects associated with new source water supply facilities. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Additional Compliance and Other Indirect Actions*, at the end of this chapter, lists potential mitigation measures associated with the construction or operation of the methods of compliance and is referenced in Table 16-25 where appropriate.

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[20] Note: Cities or water districts that do not treat wastewater would have no obligation to try to reduce the salt levels in the water they provide.

Table 16-25. Potential Environmental Effects of New Source Water Supply Facilities

Potential Environmental Effects of New Source Water Supply Facilities	
Resource	Discussion
Aesthetics	• New source water supply facilities would require the construction of new infrastructure including pipelines, canals, small lift or pump stations, and tie-in stations to existing water treatment plant intakes. Construction of the new source water supply facilities could result in temporary impacts on the visual character or quality of the chosen sites and surroundings, likely within San Joaquin County, due to ground disturbance. Ground-disturbing construction activities would have the potential to disturb or remove mature vegetation (i.e., landscaping) and create dust clouds, which could affect views. In addition, construction may involve nighttime lighting for safety and potentially 24-hour construction. The severity of these impacts would depend on the location of sensitive receptors and scenic vistas relative to the construction site. For example, San Joaquin County has no designated scenic vistas and as such an impact may not occur (San Joaquin County 2014a). However, if 24-hour construction occurs, light and glare could be produced that could affect sensitive receptors. Table 16-38 identifies potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant environmental effects day and nighttime views associated with light and glare and aesthetics. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented depending on the possible location of potential sensitive receptors and the ability to reduce light and glare. • Operation of new source water supply facilities would not be expected to significantly affect the visual character or quality of the area in which it would likely occur (i.e., San Joaquin County) Generally, the infrastructure associated with new water supply facilities would be unobtrusive structures, with low profiles and a low potential to adversely affect the daytime view of existing sensitive receptors (e.g., residents or recreationists). However, if new intakes were operated on a waterway, the siting of concrete infrastructure could result in a substantial change to the visual character and quality of the area, depending on where the area is located (e.g., adjacent to a river). Furthermore, Certain facilities, such pump stations, may require permanent outdoor lighting, which could adversely affect viewers in rural areas where there is relatively limited outdoor lighting at night. Design and operation of lights would be expected to follow lighting guidelines and lighting plans of local jurisdictions approving the construction and operation of new source water supply facilities. Many of the facilities (such as pipelines) would likely be located below ground and, once operational, would not affect the visual quality or character of an area. Table 16-38 identifies potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant environmental effects day and nighttime views associated with aesthetics and light and glare. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant

Potential Environmental Effects of New Source Water Supply Facilities

Resource	Discussion
	once mitigation measures were implemented depending on the possible location of potential sensitive receptors, the visual character and quality of the surrounding area, and the ability to reduce light and glare. • There are two state-designated scenic highways in San Joaquin County, Interstate 5 (I-5) and I-580 (San Joaquin County 2014a). Depending on the location, construction of new source water supply facilities may be visible from portions these highways and temporarily alter the existing views. However, because permanent water supply facility structures would be visually unobtrusive and because travelers on the interstates would be traveling at relatively high speeds, they are generally considered to have low visual sensitivity to changes in views. Moreover, it is not expected that the construction and operation of new source water supply facilities would substantially damage scenic resources (including trees, rock outcroppings, and historic buildings) within I-5 or I-580. Impacts would be less than significant.
Agriculture and Forestry Resources	• Construction and operation of new source water supply facilities such as pipelines, small lift or pump stations, and tie-in stations, would not be expected to be located on agricultural lands (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) because they are expected to be located along the rights-of-way of existing roads or close to existing water supply infrastructure. If canals are constructed and operated, there is the potential for canals to remove some amount of agricultural lands from production; however, the amount cannot be quantified in this analysis because the location of the canals is unknown. The extent of the impact would depend on the total acres removed from agricultural use, whether it was permanent removal, and whether they were in Williamson Act contracts. But it is expected that agricultural uses in the southern Delta would benefit from the reduction in salinity discharges provided by the new source water supplies and potentially offset any agricultural land that might be indirectly affected by the new source water supplies. Lead agencies can and should implement potential mitigation measures identified in Table 16-38 to mitigate for significant environmental effects associated with the potential permanent removal or conversion of agricultural lands. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Construction and operation of new source water supply facilities would not be expected to be located on forest land or timberland because these resources are limited in the southern Delta and because these facilities are expected to be located along the rights-of-way of existing roads or close to existing water supply infrastructure. Accordingly, there would be no conflict with existing zoning for, or cause rezoning or loss of these resources. Impacts would not occur.
Air Quality	• Construction and operation of new source water supply facilities would likely be located in the SJVAB, which generally covers San Joaquin, Stanislaus, Merced, and Madera Counties. USEPA has classified SJVAB as an extreme nonattainment area for the federal 8-hour ozone standard and a nonattainment area for the federal PM2.5 standard. For the federal CO standard, USEPA has classified most major population centers of the SJVAB as maintenance areas and rural areas of the SJVAB as unclassified/attainment areas. The SJVAB is classified as a serious maintenance area with regards to the federal PM10 standards. ARB has classified the SJVAB as a severe nonattainment area for the state 1-hour ozone standard and a nonattainment area for the state 8-hour ozone,

Potential Environmental Effects of New Source Water Supply Facilities

Resource	Discussion
	PM10, and PM2.5 standards. ARB has classified the SJVAB as an attainment area for the state CO standard. SJVAPCD's published guidelines, *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002) do not require the quantification of construction emissions. Rather, the guidelines require implementation of effective and comprehensive feasible control measures to reduce PM10 emissions (SJVAPCD 2002). SJVAPCD considers PM10 emissions to be the greatest pollutant of concern when assessing construction-related air quality impacts and has determined that compliance with its Regulation VIII, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), constitutes sufficient mitigation to reduce construction-related PM10 emissions to less-than-significant levels and minimize adverse air quality effects. All construction projects must abide by Regulation VIII. Since the publication of its guidance manual, SJVAPCD has revised some of the rules comprising Regulation VIII. Guidance from SJVAPCD staff indicates that implementation of a Dust Control Plan would satisfy all of the requirements of Regulation VIII (Siong pers. comm.). Further consultation with SJVAPCD staff indicates that, though explicit thresholds for construction-related emissions of ozone precursors are not enumerated in the *Guide for Assessing and Mitigating Air Quality Impacts*, SJVAPCD considers it to be a significant impact when construction or operational emissions of ROG or NO_X exceed 10 tons per year or if PM10 or PM2.5 emissions exceed 15 tons per year (Siong pers. comm.). SJVAPCD's CEQA Guidelines indicate their numeric thresholds are project-level and cumulative: "Any proposed project that would individually have a significant air quality impact…would also be considered to have a significant cumulative air quality impact" (SJVAPCD 2002). Construction of new source water supply facilities would likely result in emissions associated with construction equipment and construction worker vehicle trips, as well as fugitive dust emissions from ground disturbance. Construction activities would temporarily increase emissions of ozone precursors and particulate matter. The quantity, duration, and intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations that occur at any one time. More emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Depending on the level of construction activities and amount of infrastructure built, construction of new source water supply facilities could exceed air quality thresholds established by SJVAPCD, which would be a significant impact. Implementation of measures to help reduce or minimize construction-related emissions and comply with regulations would be required. Lead agencies (e.g., municipalities or municipal water purveyors) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on air quality associated with construction emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the regulatory requirement to implement all required feasible measures to reduce emissions during construction and the potential for the duration and frequency of activities during construction to reduce overall emissions (e.g., diluting emissions over time).

Potential Environmental Effects of New Source Water Supply Facilities	
Resource	Discussion
	• Operation of new source water supply facilities could include facility inspection and maintenance activities, similar to the maintenance of existing water supply facilities. The need for additional energy to distribute the new water supply could result in increased criteria pollutant emissions at other power facilities. However, the power facilities that would compensate for the additional power are already built and permitted to emit a maximum amount of criteria pollutants. These facilities are required to offset additional power generation by the use of pollution credit. Therefore, if additional emissions are generated, they would be generated by facilities that are permitted to do so. Operation of new source water supplies may use nonelectric back up during intermittent emergency situations and their cumulative operation could result in exceedances of SJVAPCD's thresholds and potentially result in a cumulatively considerable net increase in criteria pollutants for which SJVAB is in nonattainment, as SJVAPCD's CEQA Guidelines indicate their numeric thresholds are project-level and cumulative: "Any proposed project that would individually have a significant air quality impact…would also be considered to have a significant cumulative air quality impact (SJVAPCD 2002)". However, the potential short term increase in criteria pollutant emissions during intermittent emergency situations would be potentially offset by reductions in the use of electric or fuel pumps being used to lift water into canals or pipelines. Operations could include periodic facility inspection and maintenance activities. However, emissions generated once operational would be minimal and are not anticipated to exceed SJVAPCD thresholds. Impacts would be less than significant. • SJVAPCD generally defines a sensitive receptor as a facility that houses or attracts children, the elderly, people with illnesses, or others who are especially sensitive to the effects of air pollutants, and where there is a reasonable expectation of continuous human exposure according to the averaging period for National ambient air quality standards (AAQSs [e.g., 24-hour, 8-hour, or 1-hour]) (SJVAPCD 2002). Sensitive receptors are primarily concentrated in urbanized areas and their proximity to construction or operational activities, the type of activity, and duration of activity, determines their potential exposure to pollutants. If criteria pollutant standards are exceeded during construction, and sensitive receptors are in proximity, mitigation measures identified in Table 16-38 would serve to reduce potentially significant effects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. It is not anticipated that operation of the facilities would expose sensitive receptors to substantial pollutant concentrations because operations would not generate toxic or diesel exhaust. If diesel generators were used, they would be limited in operation and would likely be subject to air district permitting requirements that would minimize health risks. In addition, operation of these facilities would not create objectionable odors. Impacts on sensitive receptors related to new source water supply facility operations would be less than significant. • The ARB traditionally has established state air quality standards, maintaining oversight authority in air quality planning, developing programs for reducing emissions from motor vehicles, developing air emission inventories, collecting air quality and meteorological data, and approving State Implementation Plan, as required by the Clean Air Act, provisions. Responsibilities of local air districts include overseeing stationary source emissions, approving permits, maintaining emissions inventories. SJVAPCD has adopted an air quality improvement plan that addresses

Potential Environmental Effects of New Source Water Supply Facilities

Resource	Discussion
	NO_X and ROGs, both of which are ozone precursors and contribute to the secondary formation of PM10 and PM2.5. The air quality improvement plan specifies that regional air quality standards for ozone and PM10 concentrations can be met through the use of additional source controls and trip reduction strategies. It also establishes emission budgets for transportation and stationary sources. Those budgets, developed through air quality modeling, reveal how much air pollution can be present in an area before AAQSs are violated. General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction and operation of new source water supply facilities would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with an air quality plan if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air quality plan(s). The construction and operation of new source water supply facilities would not result in growth because it would serve to provide alternate low-salinity water source(s) to water users and would not serve to satisfy an increase in demand or an increase in need. The construction and operation of new source water supply facilities would not result in population or employment growth that would result in a conflict with or obstruct implementation of the applicable air quality plan because they would not require activities that are associated with population growth (e.g., housing development, business centers, etc.). Accordingly, this impact is less than significant. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). New source water supplies are not included in one of these categories. Therefore, construction and operation of salinity source controls would not create objectionable odors affecting a substantial number of people. Impacts would be less than significant.
Biological Resources	• Construction and operation of new source water supply facilities, such as pipelines, lift pumps, and tie-ins, would primarily be underground, in the public rights-of-way in existing roads, or adjacent to existing water supply facilities, and are expected to have a low potential to disturb habitat (potentially including established native resident or migratory wildlife corridors, federally protected wetlands, riparian habitat, or other sensitive natural communities) or candidate, sensitive or special-status species (including interfering substantially with the movement of any native resident or migratory fish or wildlife species) above ground. It is unlikely construction and operation of these underground facilities would impede the use of native wildlife nursery sites given where the facilities would likely be located. Further, because new source water facilities would likely be located in the public rights-of-way in existing roads, or adjacent to existing water supply facilities, they are not likely to conflict

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Resource	Discussion
	with local policies or ordinances protecting biological resources, or conflict with an adopted natural community conservation plan or habitat conservation plan. Impacts would be less than significant. • If canals are constructed and operated as part of new source water supply facilities, there is the potential for the canals to disturb habitat (potentially including federally protected wetlands, riparian habitat or other sensitive natural communities) and/or candidate, sensitive, or special-status species depending on the location of the canals. Similarly, if new intakes constructed and operated, there would be a high potential to affect these resources depending on its location and proximity to a waterway. However, the extent of potential disturbance cannot be quantified in this analysis because the locations of the canals are unknown. Construction and operation of canals associated with new source water supply facilities, depending on the location, could conflict with local policies or ordinances protecting biological resources. Further, construction and operation of canals or a new intake, depending on the location, could impede the use of native wildlife nursery sites. As specific source water supply facilities are designed, lead agencies (e.g., municipalities or municipal water purveyors) would be required to evaluate construction effects of new source water supply facilities, such as the potential for direct and indirect impacts on jurisdictional waters, habitat, and candidate, sensitive, or special-status species on a case-by-case basis in subsequent CEQA documents. Table 16-38 lists potential mitigation measures lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant environmental effects of construction and operation of new source water supply facilities on biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. If habitat is permanently removed as a result of constructing canals or a new intake, it is likely that impacts could not be mitigated and would remain significant and unavoidable. • Construction and operation of new source water supply facilities could occur within the SJMSCP Plan Area. The SJMSCP is administered by the San Joaquin Council of Governments (SJCOG), a non-profit corporation established by San Joaquin County and the cities of Escalon, Lathrop, Lodi, Manteca, Ripon, Stockton and Tracy. Implementation of new source water supply facilities may be considered a covered activity under SJMSCP—a determination which would be made by SJCOG, in consultation with the lead agency. If an activity is determined to be covered, participation in the SJMSCP is voluntary except when conditioned to participate by a Permittee (i.e., SJCOG, Inc. San Joaquin County, and the cities of Escalon, Lathrop, Lodi, Manteca, Ripon, Stockton and Tracy). If an activity is not covered, the lead agency can request coverage using one of the following four options: (1) payment of a fee, which is assessed depending on habitat type within which the project is located; (2) dedicate habitat lands as a conservation easement or fee title; (3) purchase mitigation bank credits from a SJCOG-approved mitigation bank; and (4) propose an alternative mitigation plan, consistent with the goals of the SJMSCP and equivalent in biological value. Participation in the SJMSCP fulfills ESA, CESA, NEPA, and CEQA requirements, provides mitigation and guarantees no additional mitigation, excepting for Incidental Take Minimization Measures required in limited cases (SJCOG 2016a). If the lead agency participates in the SJMSCP, construction and operation of the new source water supply facilities would not be considered in conflict with the SJMSCP, and impacts would be less than

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	significant. If the lead agency chooses to opt out of participation in the SJMSCP, that agency or agencies (e.g., municipalities or municipal water purveyors) can and should implement the mitigation measures identified in Table 16-38 to reduce potentially significant impacts on biological resources and to avoid conflict with the SJMSCP. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. If habitat is permanently removed as a result of constructing or operating new source water supply facilities, it is likely that impacts could not be mitigated and would remain significant and unavoidable. However, it is likely impacts could be reduced once mitigation was implemented because once a lead agency opts in or determines its action is covered, consistency would be determined and impacts would be less than significant. • Direct and indirect impacts on candidate, sensitive, or special-status biological resources or habitat are unlikely to occur during operation because the new source water supply facilities would primarily be underground and would convey water supplies from a currently unknown source to the water district or municipality water treatment plant. Further, since the water would likely come from an existing senior water right holder, it is assumed the senior water right holder is using the water for another purpose and, therefore, a change in use of the water for municipal purposes would not result in direct or indirect impacts on candidate, sensitive, or special-status species and habitat. Finally, lead agencies (e.g., municipalities or municipal water purveyors) would evaluate the operation of the new source water supply facilities and the potential for direct impacts on jurisdictional waters, habitat, and candidate, sensitive, or special-status species on a case-by-case basis in subsequent CEQA documents. Table 16-38 lists potential mitigation measures lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts on biological resources related to new source water supply facilities operations. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Cultural Resources	• Construction of the new water supply facilities could include installing pipeline generally along the rights-of-way of existing roads, new lift stations, and tie-ins to existing water supply facilities. There is the potential to encounter significant unknown buried cultural resources (significant historical, archeological, or paleontological resources) during construction because it is unknown if these resources are currently present within these sediments. At this time, no specific projects have been proposed, and the foreseeable future new source water supply facilities are unknown. Even so, given that most of the construction would occur within highly developed public rights-of-way or where much of the sediments have been previously disturbed, the potential to encounter significant buried cultural resources is greatly reduced. Construction of new water supply facilities such as canals or new intakes may involve the disturbance of ground not within the rights-of-way of existing roads, or the footprint of existing facilities, and could result in excavation at varying depths below ground surface; however, the location is unknown at this time and, therefore, it the potential to uncover unknown significant cultural resources cannot be determined. Lead agencies (e.g., municipalities or municipal water purveyors) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on cultural

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	resources associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • As described above, new water supply facilities would primarily be located within the rights-of-way of roads or at existing facilities. Therefore, it is highly unlikely human remains, would be disturbed during construction, because these areas have already been highly disturbed. However, canals may be located outside the rights-of-way of public roads and at varying depths below ground surface. In the event human remains are uncovered during construction, compliance with the State Health and Safety Code would be required. As specified by Section 7050.5 of the Health and Safety Code, and described in Table 16-38, no further disturbance would occur until the county coroner has made the necessary findings as to origin and disposition pursuant to Public Resources Code Section 5097.98. If such a discovery occurs, excavation or construction would halt in the area of the discovery, the area would be protected, and consultation and treatment would occur as prescribed by law. If the coroner recognizes the remains to be Native American, he or she would contact the NAHC, who would appoint the Most Likely Descendent. Additionally, if the human remains are determined to be Native American, a plan would be developed regarding the treatment of human remains and associated burial objects, and the plan shall be implemented under the direction of the Most Likely Descendent. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Geology and Soils	• The locations of the new source water supply facilities could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, these facilities would not bring people to the risk of earthquakes or geologic hazards, meaning the construction and operation new water supply facilities would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur. • New facilities would be required to follow all appropriate building codes and would be designed to withstand seismic-related activities as identified by the building codes. Geologic studies would also be required, and design guidelines would be incorporated into the design and build that would reduce the geologic risk to the structures. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to geology and soils associated with new structures. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the need to follow the building code and other state and federal building requirements. • Construction of the new source water supply facilities would result in limited ground-disturbing activities, which could cause soil erosion or loss of topsoil; however, ground-disturbing activities would be limited in duration and geography. Furthermore, ground-disturbing activities of 1 acre or greater would require the water district or

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	municipality to prepare and implement a SWPPP, as required by the Central Valley Water Board. The SWPPP would require soil and erosion control mechanisms to reduce the effects of soil, erosion, and runoff that may be generated during construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to soil erosion and storm water runoff associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary. • The construction and operation of new source water supply facilities would not involve constructing or operating septic tanks and, therefore, septic tanks would not be affected by soils incapable of supporting the use of them or other alternative wastewater disposal systems. Impacts would not occur.
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-7, because construction and operation of new source water supply facilities would likely result in increased use of electricity and fuels there would be an increase in GHG emissions. However, the overall increased electrical demand would be small compared to the existing electrical demand and it is unlikely to require the construction of major new power generation or transmission facilities. Regardless, it is anticipated that this increased electricity-related GHG emissions could exceed applicable SJVAPCD ZEL threshold and result in a potentially significant impact. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs • AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be

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Resource	Discussion
	inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
Hazards and Hazardous Materials	• Construction of new water supply facilities would be short term and may involve the limited transport, storage, use, and disposal of hazardous materials such as fuel and lubricating grease for motorized heavy equipment. Some examples of typical hazardous materials handling are fueling and servicing construction equipment on the site and transporting fuels, lubricating fluids, solvents, and bonding adhesives. These types of materials are not acutely hazardous, and storage, handling, and disposal of these materials are regulated by local, county, and state laws. Furthermore, the quantities of these materials used during construction would be small (e.g., less than 100 gallons) because construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because construction and the use of hazardous materials would be temporary and relatively short in duration over the course of construction. • There are eight sites within San Joaquin County that are identified on the Hazardous Waste and Substance Site List (Cortese Site list) as being hazardous materials sites under Government Code, § 65962) (CalEPA 2016). Construction and operation of new source water supply facilities are not likely to be located on these eight sites or interfere with these sites because the construction and operation of new source water supply facilities would not involve activities at the sites on this list (e.g., Lawrence Livermore National Lab, McCormick and Baxter Creosoting Company). CalEPA identifies leaking underground storage tank sites, sites that have received CDOs or clean up and abatement orders, and hazardous waste facility sites where DTSC has taken corrective Action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action in San Joaquin County (CalEPA 2016). As such, construction of new source water supply facilities would not affect them. There are approximately 244 leaking underground storage cases in San Joaquin County designated as open (CalEPA 2016). Sixteen facilities in San Joaquin County have received CDOs or CAOs and have active cases, but may not be necessarily related to hazardous waste (CalEPA 2016). The location of construction of new source water supply facilities is unknown, but it is not anticipated to be located directly on these sites because they include locations such as gas stations, car washes, private lands with underground storage tanks. However, construction could occur along the rights of way of existing roads that could be in proximity to these sites. During excavation or soil disturbance potentially contaminated soil could be encountered. As such, Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and

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	should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • San Joaquin County has 14 school districts and more than 200 schools (San Joaquin County Office of Education n.d.). The location of construction of new surface water facilities is unknown; however, construction could be located within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected these materials would be handled, used, and stored properly in accordance with local, state, and federal laws and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation activities. As such, if a school existed within close proximity to construction of new source water facilities, those mitigation measures identified Table 16-38 applied to project-specific construction needs would reduce potentially significant impacts during construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction • Construction of new source water supply facilities, such as pipelines, lift stations, or tie-ins, would not physically interfere with an adopted emergency response plans or emergency evacuation plans since they would likely be located in the existing rights-of-way of public roads or within the footprint of other existing water supply infrastructure. During construction, road shoulders or lanes may be closed, but traffic construction workers would be employed to direct and control traffic as is typical during construction work that occurs in the rights-of-way of public roads. Road shoulders or lanes may be closed as a result of construction of canals if the canals are adjacent to roads or cross roads. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with traffic and potential conflicts with emergency response. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary. • Once new source water supply facilities are operational, they would either be underground, adjacent to existing water supply infrastructure, or contained in a canal and would not physically interfere with an emergency

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Resource	Discussion
	response plan or emergency evacuation plan because they would not prevent road access. Furthermore, operation does not involve an increase in population that would necessitate reconsideration of how to evacuate people in an emergency. • Assuming construction and operation of new source water supply facilities would be located in San Joaquin County, there are six public access airports within the county (SJCOG n.d.[a]). The Stockton Metropolitan Airport and San Joaquin County Airport have approved Airport Land Use Compatibility Plans, which prescribe safety requirements and ensure land uses would not pose a safety hazard to the airports in accordance with the Federal Aviation Administration. Other airports, such as the City of Tracy, have either airport master plans or other planning documents outlining safety requirements and ensuring land uses would not pose a safety hazard, consistent with FAA requirements (City of Tracy 1998). The location of construction or operation of new source water supply facilities is unknown and could occur within 2 miles of an airport. However, construction and operation new source water supply facilities would not be a hazard or cause safety concerns to airports since the facilities would be relatively low profile and/or underground. Impacts would not occur. • Construction and operation of new source water supply facilities would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur.
Hydrology and Water Quality	• Construction of new source water supply facilities could result in temporary changes to storm water drainage, existing drainage patterns, erosion, or runoff associated with typical construction activities such as grading or preparation of land. As discussed earlier in this table (Geology and Soils), soil disturbance of over 1 acre would require water districts or municipalities to prepare and implement a SWPPP, which would include specific types and sources of storm water pollutants, determine the location and nature of potential impacts, and specify appropriate control measures to eliminate any potentially significant impacts from storm water runoff on receiving waters. In addition, as discussed in this table for Hazards and Hazardous Materials, construction of new source water supply facilities may involve the limited transport, storage, use, and disposal of hazardous materials, which, if spilled, could have adverse effects on water quality depending on the location and magnitude of the spill. However, storage, handling, and disposal of these materials is regulated by local, county, and state laws, and the quantities of these materials used during construction would be small (e.g., less than 100 gallons) and construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained and, as such, violations of water quality standards are not expected to occur. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary and the need to follow existing regulations requiring the handling, use and disposal of hazardous materials, and the need to prepare SWPPPs.

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	• Under operating conditions of a new source water supply facility, a water district or municipality would need to purchase water from a source such as an irrigation district. The source would have a water right to obtain water from various locations and allocate the amount of water as allowed by its water right(s). Therefore, impacts on hydrology and water quality are not expected to occur under operating conditions of new source water supplies because the water district or municipality could not obtain water from a source that was out of compliance with its water right. Impacts would be less than significant. • It is unknown if new source water supply facilities would be located in a 100-year flood hazard area. However, the new source water supply facilities would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to flood hazard locations or result in the construction of housing in a flood hazard area. Accordingly, new source water supply facilities would not expose people to significant loss, injury, or death related to flooding. Construction of new source water supply facilities would not result in flooding or otherwise cause flooding, including flooding as a result of the failure of a levee or dam. The new source water supply facilities are expected to be low in profile and/or underground and would, therefore, not impede or redirect flood flows. Impacts would be less than significant. • Construction and operation of new source water supply facilities would not result in a substantial depletion of groundwater supplies because surface water would be the supply source. The operation of the facilities and any impervious surfaces needed would be minimal from a regional groundwater basin perspective; therefore, new source water supply facilities would not interfere with groundwater recharge. Further, new source water supplies could actually reduce the amount of groundwater pumped because typically groundwater is saline, and the use of it increases the salinity concentration in the treated effluent discharged into the southern Delta. Impacts would be less than significant. • Construction and operation of new source water supply facilities would primarily be located in areas of relatively flat relief because pipelines and canals are typically not located on the side of steep slopes. Therefore, these locations would not support mudflows, which typically need very steep slopes and large amounts of precipitation to occur. Furthermore, these areas would not be adjacent to the ocean and, therefore, they would not be affected by tsunamis. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction and operation of new source water supply facilities are not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of new source water supply facilities could result in a substantial degradation to water quality.

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Resource	Discussion
Land Use and Planning	• Construction and operation of new source water supply facilities would not physically divide an established community because the facilities would be located either underground or on land likely designated for infrastructure. Impacts would not occur. • Typically, general land use designations and zoning designations allow for the development of infrastructure, such as pipelines or pumping stations. It is not anticipated that the construction or operation of the new source water supply facilities would result in a conflict with land use designations or zoning. If the new source water supply facilities were inconsistent with applicable land use plans, policies, or regulations, an amendment or variant from the local jurisdiction approving the discretionary action associated with the facilities would be required by the project proponent (e.g., water district or municipality) prior to project approval and construction. If no discretionary action were to occur as a result of the construction or operation of the facilities, it is assumed it would not result in a conflict with local land use plans, policies or regulations. Impacts would be less than significant. • Construction and operation of new source water supply facilities would likely take place in the Delta and may be considered covered activities under the Delta Plan. Only the lead CEQA state or local agency may determine whether that plan, program, or project is a covered action of the Delta Plan. If an action is covered, consistency with the Delta Plan would be determined. The consistency determination would include implementing mitigation from the Mitigation Monitoring or Reporting Program of the Delta Plan, as appropriate. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to consistency with the Delta Plan. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely impacts could be reduced once mitigation was implemented because once a lead agency determines an action is covered and complies with the Mitigation Monitoring or Reporting Program, consistency would be determined and impacts would be less than significant. • Potential conflicts with habitat conservation plans, natural community conservation plans, or other plans, policies and regulations protecting biological species and resources are evaluated in the Biological Resources section of this table.
Mineral Resources	• The California Surface Mining and Reclamation Act (SMARA) requires the State Geologist to classify land into mineral resource zones (MZ), according to the known or inferred mineral potential of existing land. The primary goal of mineral land classification is to ensure that the mineral potential of land is recognized by local government decision-makers and considered before land-use decisions are made that could preclude mining. Local general plans, specific plans, and other local plans refer to and use the information produced by the State Geologist, to identify mineral resources because they are specialized evaluations and because the California Geologic Survey is the designated agency to perform these surveys under SMARA. MZ are identified by the State to identify inferred mineral potential of an area. Areas designated MZ-1 have adequate information to determine no significant mineral resources exist, or indicate a very low likelihood; areas designated MZ-2 have adequate information to

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Resource	Discussion
	identify significant mineral deposits or indicate a high likelihood of presence; and areas designated MZ-3 have inadequate information to determine significance of mineral deposits, but contain mineral deposits. Some gravel, sand, and aggregate resources (identified as MZ-1 or MZ-2) are found in close proximity to waterways and the LSJR in San Joaquin County (San Joaquin County 1998, City of Tracy 2005). Most of the city of Stockton is designated as MZ-1, with a small area of MZ-3 (City of Stockton 2007). Other mineral resources, such as gold or peat, have been previously extracted from the county (San Joaquin County 1998). • Construction and operation of new source water supply facilities would have a very low potential to result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally designated mineral resource recovery site. This is because the new source water supply facilities would likely be located within the rights-of-way of existing public roads or adjacent to water supply facilities. Additionally, if the new source water supply facilities are located within a state or locally designated mineral resource area, construction and operation of the facilities would not permanently remove access to a mineral resource as there would be other locations around the facilities that could provide access to the mineral resource. Impacts would be less than significant.
Noise	• Construction would potentially take place in San Joaquin County, and the cities of Tracy and Stockton depending on the location of water supply facilities. But it could also take place within one of the other multiple cities within San Joaquin County, depending on whether the construction of pipelines or canals would occur and their specific location(s). Each of these jurisdictions have noise requirements in their general plans or zoning ordinances for construction and operation based on land use designations and timing restrictions. Noise requirements are typically based on land uses that are considered more sensitive to ambient noise levels than others due to noise exposure. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and outdoor recreation or natural areas are typically more sensitive to noise than are commercial or industrial land uses. Therefore, local noise standards are typically more stringent for sensitive land uses in terms of level of noise generated, duration, and frequency than less sensitive uses. Given the wide ranges of land uses throughout San Joaquin County, noise levels can range from louder high density residential and industrial uses or roadway uses to more quiet open space and agricultural areas (San Joaquin County 1992). Frequently, the most common and loud noise generating activity in San Joaquin County affecting the overall permanent ambient noise setting is freeway traffic on I-5, I-205, and SR-4 and along railroads and in heavy industrial areas (e.g., Port of Stockton) or around airports (San Joaquin County 1992). It is unknown where construction or operation of the new source water supply facilities would take place, so it is unknown if construction or operation would occur within or in close proximity to a noise sensitive land use (e.g., residences) or in an area less sensitive to noise (e.g., industrial area). • The City of Tracy and the City of Stockton regulate generation of construction noise by restricting the timing that construction can occur (e.g., operating construction requirement from 10pm to 7pm is prohibited) and the land use or adjacent land uses under which the noise generating activity occurs (City of Stockton n.d., City of Tracy n.d.). San Joaquin County exempts noise sources associated with construction, provided they do not take place before 6am or after 9pm (San Joaquin County n.d.) Other local jurisdictions also either exempt construction noise from

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Resource	Discussion
	noise standards or have restrictions as to when it can occur. Construction of new source water supplies could generate temporary noise and as such could expose people to noise levels in excess of standards. Construction of the new source water supply facilities could exceed noise standards established in local general plans or noise ordinances, depending on the location of sensitive receptors, the type of construction equipment used, and the duration of construction. As such, could result in the temporary increase in ambient noise levels and expose persons to noise levels in excess of applicable noise standards. While construction would generally occur within rights-of-way along public roads; however, it is unknown where certain facilities, such as canals, would be located. They could be located in residential neighborhoods or within immediate proximity to other sensitive receptors (e.g., schools, hospitals, parks). If sensitive receptors were adjacent to construction activities and experienced construction noise, construction would likely be temporary and it would be required to follow existing local noise ordinances limiting the timing of construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Construction activities that typical result in ground-borne vibrations or ground-borne noise are activities such as pile driving, where the ground is repeatedly struck and vibrations or noise can be generated. Given the nature of the facilities constructed (e.g., canals, pump stations, pipelines), it is likely that construction activities such as digging, excavating, and more standard practices and less vibration producing activities, would be used as opposed to pile driving. Furthermore, some local agencies (e.g., San Joaquin County) exempt vibrations associated with construction provided it is occurring within certain hours (San Joaquin County n.d). However, if pile driving is used, and there are sensitive receptors to noise (e.g., homes, hospitals, schools) within close proximity, Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant noise impacts related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the potential location of possible sensitive receptors the duration of the particular noise generating activities over the course of construction. • Once operational, the new source water supply facilities would be located underground and may include some lift stations. Although the location of the lift pump stations is unknown, it is unlikely they would generate sufficient permanent noise to exceed noise standards established by a local general plan or noise ordinance. This is because they would likely be enclosed for security purposes by some type of enclosed structure or fencing that would reduce noise generated. As such, a permanent increase in ambient noise under operating conditions is not expected. Impacts would be less than significant. • Assuming construction and operation of new source water supply facilities would be located in San Joaquin County, there are six public access airports within the county (SJCOG n.d.[a]). The Stockton Metropolitan Airport, San Joaquin County Airport have approved Airport Land Use Compatibility Plans, which identifies noise contours

Potential Environmental Effects of New Source Water Supply Facilities	
Resource	Discussion
	and where noise exposures may take place as a result of aircraft flight patterns consistent with Federal Aviation Administration requirements (SJCOG n.d.[a]). Other airports, such as the City of Tracy, have either airport master plans or other planning documents (e.g., general plans) that outline noise contours consistent with FAA requirements (City of Tracy 1998). While it is unknown where construction or operation of new source water supply facilities might occur, the construction and operation of new source water supply facilities would not bring new or additional people within close proximity to an airport or private airstrip or expose people to noise generated by air traffic on a regular basis. This is because new source water supply facilities would not result in an increased permanent work force cited within proximity to an airport or private airstrip. Nor would new source water supply facilities result in a population increase that would be exposed to airport noise. Impacts would not occur.
Population and Housing	• The construction and operation of new source water supply facilities would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area because the new water supply would be in lieu of higher-salinity water and would not result in a greater supply of water (i.e., source water supply facilities would not be constructed and operated to increase capacity to serve new users). New source water supply facilities would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people to the southern Delta. In addition, construction and operation of new source water supply facilities would not displace existing housing because the facilities would be located either underground or on land likely designated for infrastructure. Impacts would be less than significant.
Public Services	• The need for additional public services (e.g., fire protection, police protection, parks, libraries, schools) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, construction and operation of new source water supply facilities would not involve an increase in population or housing. In addition, construction and operation of new source water supply facilities would not include proposals for new housing and would not generate students or increased demands for school services or facilities. Impacts would not occur.
Recreation	• Construction of new source water supply facilities would likely occur in the rights-of-way of public roads or adjacent to water supply infrastructure. If recreational facilities were located within very close proximity to construction, recreation could be affected by noise levels or other temporary construction activities. An increase in use of existing recreational facilities is typically associated with a substantial increase in the population to accommodate new recreationists. Construction or operation of new source water supply facilities would not result in a substantial increase in population because it would not result in the development of housing or other population-inducing development (e.g., job centers). The purpose of the construction and operation of new source water supply facilities would be to comply with water quality objectives. Construction and operation of these facilities would satisfy existing demand, not meet new projected demand for wastewater treatment (Sections 16.4.2, *Salinity Pretreatment Programs*, and 16.4.3, *Desalination*) or water supply. If construction occurs within

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Resource	Discussion
	close proximity to existing recreational resources, Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to construction noise, traffic, or air quality, if those types of impacts occur within close proximity to existing recreational facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the construction timeframe and the location of potential sensitive receptors and recreational resources, and also because construction if certain components (e.g., segments of pipelines) would generally temporary and relatively short in duration. • Construction and operation of new source water supply facilities would not include recreational facilities or require the construction or expansion of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Assuming construction and operation of new source water supplies would be located within San Joaquin County, projects would be subject to the SJCOG Regional Congestion Management Program (SJCOG 2016b). A total of 103 intersections have been designated as part of San Joaquin County Council of Governments Regional Congestion Management Program (SJCOG n.d.[b]). Designation of RCMP intersections allows for congestion monitoring and appropriately focuses attention at locations where operational constraints are typically experienced on arterial roadways (SJCOG n.d.[b]). As described in the Regional Congestion Management Program, projects are subject to a tiered review process, unless exempt from CEQA or unless considered as part of a previously. Projects that trigger 125 or more vehicle trips during weekday AM or PM peak-hours or 500 or more total vehicle daily trips on any day of the week would be required to perform a quantitative regional traffic analysis. The Regional Congestion Management Program provides for mitigation to reduce effects approved project (SJCOG 2016b) if trips occur at those levels. Trips that are exempted from the RCMP standards, and are removed from calculations of LOS standards under the RCMP include trips resulting from construction (SJCOG 2013). Regional deficiencies have been identified on portions of congestion management program roadway segments in San Joaquin County, including Intrastate-5 and State Routes (SR) 4, 88, 99, and 120 because they are operating at a level of service (LOS)[21] of E or F (Table 2 in Dowling Associates 2010). Several congestion management program roadway segments are also operating at LOS D (Table 3 in Dowling Associates 2010). Of approximately 1,500 congestion management roadway segment miles, 245 operate at LOS D, with approximately half of these in the County, and the remaining in the cities of Stockton, Lathrop, and Manteca and Tracy (Table 4 in Dowling Associates 2010). There are approximately 92 miles of CMP lanes operating at LOS E or F, with more than half located in county areas, and 16 percent in Stockton (Table 4 in Dowling Associates 2010). Operation of new source water supply

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[21] Level of Service is a standard transportation evaluation term and is a qualitative measure of traffic operating conditions or system adequacy. It is typically defined on a scale using the letters A through F (best to worse). LOS A is free flowing conditions with little or no delay and LOS E is flow conditions at traffic volumes at or near design capacity. LOS F represents unstable forced flow exceeding capacity, resulting in greatly reduced travel speeds.

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Resource	Discussion
	facilities would likely not generate additional trips beyond those required to maintain the existing facilities and would likely not exceed the thresholds identified in the RCMP (e.g., 125 or more vehicle trips during weekday AM or PM peak-hours or 500 or more total vehicle daily trips on any day of the week). This is because would be unlikely that operation of the facilities would result in a substantial increase in the number of water district or municipality employees. Therefore, construction and operation of new source water supply facilities is expected to comply with the RCMP. Impacts would be less than significant. • Construction and operation of new source water supply facilities could result in some additional trips. These facilities may be located in urban and suburban areas that could already experience some congestion on existing roadways. It is unknown the number of construction and operational trips that might be needed for these facilities and the location of these trips, but it is anticipated that construction would be relatively limited in duration and the number of operational trips would be limited, given a substantial increase in the number of water district or municipality employees is not expected. Typically, construction activities are exempt from local road trip thresholds because construction is considered temporary; however, depending on the quantity of trips, and the duration, a temporary increase in traffic during construction or under operating conditions could exceed local road trip thresholds (either vehicle miles traveled or level of service[22]). Projects would be required to evaluate trip generating activities through the respective jurisdiction traffic impact analysis guidelines, depending on the location and number of trips generated (City of Stockton n.d.). Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts of transportation and traffic related to construction or operation. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because construction impacts would be temporary and because operations are not expected to result in a substantial increase in employees. • Construction of new source water supplies is not expected to result in hazards to, or on, roadways because they would primarily be constructed within existing footprints of facilities or along the rights-of-way of roads. The development of project-specific construction traffic management plans, as identified in Table 16-38 would reduce potentially significant impacts if hazards on the roadway were temporarily created during construction due to

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[22] In January of 2016, the Office of Planning and Research (OPR) prepared a revised proposal on updates to State CEQA Guidelines for evaluating transportation impacts. The proposed methodology to evaluate transportation impacts includes replacing the standard level of service (LOS) evaluation with vehicle miles traveled (VMT) as identified in Senate Bill 743 (Steinberg, 2013). In the proposal, OPR recommends the new procedures and methods remain optional for a two-year period. This would allow agencies that are ready to switch from LOS to VMT to do so, but gives time to other agencies that may need to adjust protocols and data sources. OPR formally closed comment period on the proposal at the end of February 2016. OPR will submit a draft of the proposed revisions based on vehicle miles traveled to the Natural Resources Agency, which would then commence with a formal rule making process. (OPR 2016.)

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Resource	Discussion
	lane closures or other types of construction related activities. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts of transportation and traffic related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because construction impacts would be temporary. • Similar to the discussion in Hazards and Hazardous Materials, it is not expected that construction of new source water supplies to result in inadequate emergency access, given the location of the construction work would primarily be on the rights-of-way of roads or within the existing footprint of water supply facilities. However, Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with traffic and potential conflicts with emergency response. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. It is likely that impacts would be mitigated to less than significant once mitigation measures were implemented given construction would be temporary. • The Regional Congestion Management Program identifies multimodal corridors within the county where the operational performance of pedestrian, bicycle, transit passengers, and motorists are considered holistically (SJCOG 2012a). In addition, the Regional Congestion Management Program identifies a regional bikeway network throughout the county with existing and planned bikeways (SJCOG 2012b). Construction of new source water supplies may temporarily conflict with public transit or bicycle or pedestrian facilities if lane closures are required during construction. Depending on the location, this could temporarily remove these types of facilities, if construction activities need to occur immediately adjacent to them. However, the project-specific congestion management plans identified in Table 16-38 would include details of transit facility closures or relocations, and procedures for re-routing pedestrian or bicycle traffic, based on the particular circumstance of the project-specific location and construction activity. As such, Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts associated with public transit facilities, bicycle facilities, or pedestrian facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary. • Construction and operation of new source water supplies would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and is not related to air traffic or airports. Impacts would not occur. • Operation of new source water supply facilities is not expected to result in a permanent substantial increase in hazards due to a design feature or incompatible use, permanent inadequacy of emergency access, or a permanent

Potential Environmental Effects of New Source Water Supply Facilities

Resource	Discussion
	change that would decrease the performance or safety of public transit facilities, public biking facilities, or public pedestrian facilities because it is anticipated that some of the new source water supply facilities would be underground in operating conditions. For those facilities that would be above ground, they would comply with safety requirements and local building requirements ensuring access and safety. Impacts would be less than significant.
Utilities and Service Systems	• Construction and operation of new source water supply facilities is not be expected to exceed wastewater treatment requirements of the Central Valley Water Board because it would not involve the discharge of treated effluent. Instead, it would actually help comply with effluent limitations for salinity because it is expected the lower-salinity source water would result in lower-salinity treated effluent discharged into the southern Delta. Additionally, it would not increase the volume of wastewater delivered to the WWTP or result in a determination by the wastewater treatment provider that it has inadequate capacity to meet the service area's demand for wastewater treatment. Impacts would be less than significant. • Construction and operation of new source water supply facilities would not involve the construction of wastewater treatment facilities. Impacts would not occur. • Construction and operation of new source water supply facilities does involve the construction of water supply infrastructure. Environmental effects associated with water supply infrastructure are discussed earlier in this table (Aesthetics through Transportation and Traffic). Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant construction and operation impacts related to all environmental resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Construction and operation of new source water supply facilities are not expected to require construction of additional storm water drains because the facilities would either be underground (e.g., pipelines) or be conveyance canals that would not generate substantial volumes of runoff. Existing storm water infrastructure is expected to be sufficient. Impacts would be less than significant. • In order to operate the new source water supply facilities municipalities may need to enter into contracts to purchase surface water from senior surface water users. It is anticipated that the new source water would come from existing entitlements and either purchased through different contracted vehicles, or potentially transferred, to municipalities. As such, it is not expected new entitlements for surface water would be needed. Impacts would be less than significant. • Construction and operation of new source water supply facilities would be unlikely to generate substantial amounts or increase solid waste. The new source water supply facilities would move water from one location to another and would not generate solid waste. Solid waste generated during construction would be disposed of at landfills and would comply with all applicable laws related to construction debris recycling and solid waste disposal in California. Impacts would be less than significant.

16.4.2 Salinity Pretreatment Programs

A salinity pretreatment program would target salinity loading in a wastewater service provider's wastewater collection system from domestic (residential) and CII sources. It would provide salinity source controls at different locations within a service district to reduce the overall salt loading into the sewer system.

Domestic water similar to that found in the southern Delta may have a high concentration of minerals (typically magnesium and calcium). Water softeners are frequently used in residences to remove these minerals. During a water softener's recharge cycle, brine is used to clean the system and remove magnesium and calcium that accumulate in the mineral exchange tank. The recharge water, with suspended minerals, is then discharged to the wastewater collection system. This brine[23] and mineral solution is rarely treated at a wastewater treatment facility. By removing self-regenerating (or "automatic") water softeners, there would be a reduction of salinity discharged to the wastewater collection system, and as a result, salinity in the effluent discharged in the southern Delta would be reduced. Many wastewater treatment agencies operate a water softener buy-back program to remove water softeners from domestic use.

Salts also can enter the wastewater collection system as a byproduct commercial activities, industrial processes, and food preparation activities. CII dischargers can contribute to elevated salt loads entering the wastewater collection system and discharging into the southern Delta. Some CII sources of salinity are commercial laundry facilities, food processing operations, and industrial fabrication shops. To address salinity loading by CII dischargers, many wastewater treatment agencies prohibit CII users from discharging to the wastewater collection system or strictly regulate the quality of wastewater entering the wastewater collection system. To reduce the wastewater salt concentration from CII sources, a variety of pollution-control methods can be used, such as BMPs and desalination devices, depending on the activities conducted by the CII discharger. These methods are typically applied at the CII source generating the wastewater.

Cost Evaluation

Many wastewater treatment agencies offer rebate programs for removal of water softeners. Currently, the Inland Empire Utilities Agency (IEUA) and the Los Angeles County Sanitation Districts (LACSD) offer $206–$2,000 to homeowners to remove water softeners (Proctor pers. comm., Ghuman pers. comm.). Rules for each agency's programs differ, but in general, once a homeowner certifies that the water softener is removed (and it is later verified by the wastewater treatment agency), the wastewater treatment agency will reimburse the homeowner for the cost of removal.

To operate a water softener buy-back program, a wastewater treatment agency must advertise the program, coordinate inspections, process rebate claims, and conduct verification inspections. In some cases, the wastewater treatment agency will hire a plumber to remove water softeners. The administrative support for an in-home water softener rebate program varies. Table 16-26, *Inland Empire Utilities Agency Water Softener Buy-Back Program Costs*, and Table 16-27, *Los Angeles County Sanitation Districts Water Softener Buy-Back Program Costs,* offer general program costs for IEUA and LACSD.

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[23] Brine is the saline solution prevented from traveling through an RO filter.

High and low estimates for water softener buy-back program costs were obtained by dividing the amount each entity spent on rebates by the upper and lower bounds of the eligible rebate amounts, which provided a high and low estimate of the number of rebates issued. The total program cost was divided by the estimated number of rebates issued to obtain a per rebate cost.

Table 16-26. Inland Empire Utilities Agency Water Softener Buy-Back Program Costs

	Cost
Program Duration	4 years
Total Program Cost	$639,541
Total Amount Spent on Rebates	$307,453
Eligible Range of Rebate	$300–$2,000
Number of Rebates Actually Issued	463
Low Estimate – Program Cost Per $300 Rebate Issued	$620
High Estimate – Program Cost Per $2,000 Rebate Issued	$4,160
Actual Cost – Program Cost Per Rebate Issued	$1,380

Source: Proctor pers. comm.

Table 16-27. Los Angeles County Sanitation Districts Water Softener Buy-Back Program Costs

	Cost
Program Duration	7 years
Total Program Cost	$ 5,931,388
Total Amount Spent on Rebates	$ 2,631,667
Eligible Range of Rebate	$206–$2,000
Number of Rebates Actually Issued	NA
Low Estimate – Program Cost Per $206 Rebate Issued	$460
High Estimate – Program Cost Per $2,000 Rebate Issued	$4,510
Actual Cost – Program Cost Per Rebate Issued	NA

Source: Ghuman pers. comm.
NA = not applicable.

Based on the information presented in Table 16-26, *Inland Empire Utilities Agency Water Softener Buy-Back Program Costs* and Table 16-27, *Los Angeles County Sanitation Districts Water Softener Buy-Back Program Costs*, if a wastewater treatment agency anticipates replacing 2,000 water softeners over 5 years, the agency can reasonably expect to pay $920,000–$9,020,000 over a period of 5 years.

Processes to pretreat CII wastewater vary due to discharger type and source. In some cases, an activity can be modified to reduce the amount of salts discharged to the wastewater collection system. Some general examples of BMPs that a wastewater treatment agency's pretreatment program could implement to reduce salinity are to conserve water, pretreat water, install a desalination device, reduce water runoff, use process water for landscape irrigation, or dispose of solids in landfills instead of in the wastewater collection system.

The costs of some BMPs (e.g., disposing of solids in landfills) have nominal costs (e.g., higher garbage removal cost). Other BMPs may save the CII discharger money (e.g., using process water for landscape irrigation could reduce the user's monthly water bill).

When a CII discharger decides to install a desalination device, costs vary based on what is being discharged, the volume, and the desired wastewater salt concentration entering the wastewater collection system. Some light commercial reverse osmosis (RO) filtration systems cost as little as $1,000 to install and $200 per year to operate. These systems would treat the domestic water supply for the specific discharger, but the waste brine from the RO process must be thrown away in a landfill and not discharged to the wastewater collection system. Other systems cost millions to install and tens of thousands to operate per year, per user. In some areas, the wastewater treatment agency will bear the cost of procuring and installing a CII pretreatment device; in other areas, the costs will be split between the CII discharger and the wastewater treatment agency.

Environmental Evaluation

Summary of Potential Action

Salinity pretreatment programs would provide salinity source controls at residential homes or existing CII facilities within a wastewater treatment service provider's service area. It is anticipated that the following municipalities and wastewater treatment service providers that discharge into the southern Delta could implement such programs: City of Tracy, City of Stockton, and Mountain House CSD. The decision to implement pretreatment programs would include many variables, such as the type and number of CII wastewater dischargers in the service area of each service provider and the availability of funding to implement a residential home program.

For residential homes, the program would request or compensate residential users to modify their activities. For CII users, a salinity pretreatment program would be expected to modify existing CII processes and/or require the construction and operation of salinity source controls, such as RO. These salinity source controls would be located at existing CII facilities. The location, timing of construction, and details of operation of CII salinity source controls is unknown. However, any new salinity source controls at an existing CII facility would likely be constructed and operated within an existing CII facility footprint or within close proximity. This is because salinity source controls would have to be integrated with the CII water supply connection or wastewater discharge to capture and treat the water either prior to the CII process or capture and treat it prior to discharge into the sewer system. It is expected that the CII facility would be located in urban areas with other CII uses because generally land uses such as these are located in appropriately designated and zoned areas of municipalities. It is anticipated these salinity source controls at CII facilities would not require additional employees and would not modify or change the volume of CII wastewater discharged into the sewer system. However, it is anticipated the salt concentration of the wastewater would be lower as the salinity source controls would reduce the salinity of the wastewater.

Potential Environmental Effects

For CII users, a salinity pretreatment program would be expected to modify existing CII processes and/or require the construction and operation of salinity source controls, as described above. These salinity source controls would be located at existing CII facilities because salinity source controls would have to be integrated with the CII water supply connection or wastewater discharge to capture and treat the water either prior to the CII process or capture and treat it prior to discharge into the sewer system. Depending on the scale and magnitude of the changes to CII facilities they could meet the requirements of a categorical exemption under CEQA. CEQA allows categorical exemptions for classes of projects which have been determined not to have a significant effect on the environment. (Pub. Res. Code, § 21084.) Specifically, the following types of facilities and activities are exempt under a Class 1 or Class 3 categorical exemption.

- Minor alterations of the existing public or private structure without expanding existing uses.
- Installation of small new equipment and facilities.

In addition, Class 2 categorical exemptions allow for the replacement or reconstruction of existing facilities where the new structure will be located on the same site and will have the same purpose and capacity as the structure replaced. Some fish screen projects could meet the requirements for this exemption.

If salinity control measures at CII facilities do not meet the requirements of a categorical exemption, depending on the size of disturbance, construction may result in temporary and localized effects typically associated with construction activities. As such, installation of salinity control equipment at existing CII facilities could involve short-term construction-related effects, such as air quality and ground-disturbing effects. Any construction of new facilities at existing CII locations would not be likely to affect natural or cultural resources (significant historical, archaeological, or paleontological resources) as those locations because these areas are already highly disturbed. Programs involving residential users would be expected to have less-than-significant environmental effects. There may be some highly concentrated salt waste as a result of the operation of the pretreatment salinity source controls. This concentrated waste could not be disposed of in the sewer and would likely need to be trucked offsite and disposed of in an appropriate landfill depending on the waste classification and in compliance with all applicable laws, ordinances, and regulations. To the extent such programs were successful in reducing salinity in the southern Delta, agricultural uses and aquatic resources would benefit.

Table 16-28, *Potential Environmental Effects of Salinity Source Controls*, summarizes the potential environmental effects associated with salinity source controls at CII facilities. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* at the end of this chapter, lists potential mitigation measures associated with the construction or operation of the methods of compliance and is referenced in Table 16-28 where appropriate.

Table 16-28. Potential Environmental Effects of Salinity Source Controls

Potential Environmental Effects of Salinity Source Controls	
Resource	Discussion
Aesthetics	• Construction and operation of salinity source controls at existing CII facilities would not be expected to substantially degrade the visual character or quality of areas, have a substantial adverse effect on a scenic vista, or substantially damage scenic resources within the state-designated scenic highways in San Joaquin County, I-5 and I-580, because the facilities would be located within the existing footprint of other CII facilities. The salinity source controls would be either much smaller than the existing CII facilities or similar in size and scale as the existing facilities so the wastewater generated by the CII process can be targeted and treated. Construction and operation of salinity source controls may involve operational and safety lights. Impacts associated with lighting would depend on the location of sensitive receptors to potential lighting; however, lights would be expected to follow lighting guidelines and lighting plans of local jurisdictions approving the construction and operation of the salinity source controls. In addition, as stated above, the salinity source controls would likely be within existing CII facilities and infrastructure, which may already have operational and safety lighting, and thus it would likely not be necessary to add additional lighting. If sensitive receptors are present, Table 16-38 identifies potential mitigation measures lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant environmental effects associated with lighting. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented depending on the possible location of potential sensitive receptors and the ability to reduce light and glare
Agriculture and Forestry Resources	• Construction and operation of salinity source controls would not be expected to be located on lands used for agriculture or directly or indirectly convert agricultural lands (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) to nonagricultural uses because the salinity source controls would be located within the footprint of existing CII facilities. Because salinity source controls would likely not be located on agricultural lands, there would not be a conflict with existing zoning for agricultural use, or a Williamson Act contract. Additionally, it is expected that agricultural uses in the southern Delta would benefit from the reduction in salinity and potentially offset any agricultural land that might be indirectly affected by the salinity source controls. Impacts would not occur. • Construction and operation of salinity source controls would not be expected to be located on forest land or timberland or result in the conversion of those resources because these resources are limited in the southern Delta, and because the salinity source controls would be located within the footprint of existing CII facilities. Therefore salinity source controls would not conflict with existing zoning for, or cause rezoning or loss of these resources. Impacts would not occur.
Air Quality	• CII facilities that would implement salinity source controls would likely be constructed and operated within the SJVAB, which generally covers San Joaquin, Stanislaus, Merced, and Madera Counties. USEPA has classified SJVAB as an extreme nonattainment area for the federal 8-hour ozone standard and a nonattainment area for the federal PM2.5 standard. For the federal CO standard, USEPA has classified most major population centers of the SJVAB as maintenance areas and rural areas of the SJVAB as unclassified/attainment areas. The SJVAB is classified as a serious maintenance area with regards to the federal PM10 standards. ARB has classified the SJVAB as a severe nonattainment area for the state 1-hour ozone standard

Potential Environmental Effects of Salinity Source Controls

Resource	Discussion
	and a nonattainment area for the state 8-hour ozone, PM10, and PM2.5 standards. ARB has classified the SJVAB as an attainment area for the state CO standard. SJVAPCD's published guidelines, *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002) do not require the quantification of construction emissions. Rather, the guidelines require implementation of effective and comprehensive feasible control measures to reduce PM10 emissions (SJVAPCD 2002). SJVAPCD considers PM10 emissions to be the greatest pollutant of concern when assessing construction-related air quality impacts and has determined that compliance with its Regulation VIII, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), constitutes sufficient mitigation to reduce construction-related PM10 emissions to less-than-significant levels and minimize adverse air quality effects. All construction projects must abide by Regulation VIII. Since the publication of SJVAPCD's guidance manual, the district has revised some of the rules comprising Regulation VIII. Guidance from SJVAPCD staff indicates that implementation of a Dust Control Plan would satisfy all of the requirements of SJVAPCD Regulation VIII (Siong pers. comm.). Further consultation with SJVAPCD staff indicates that, though explicit thresholds for construction-related emissions of ozone precursors are not enumerated in the *Guide for Assessing and Mitigating Air Quality Impacts*, SJVAPCD considers it a significant impact when construction or operational emissions of ROG or NO_X exceed 10 tons per year or if PM10 or PM2.5 emissions exceed 15 tons per year (Siong pers. comm.). SJVAPCD's CEQA Guidelines indicate their numeric thresholds are project-level and cumulative: "Any proposed project that would individually have a significant air quality impact…would also be considered to have a significant cumulative air quality impact (SJVAPCD 2002)" • Construction of salinity source controls would likely result in emissions associated with construction equipment, construction worker vehicle trips, and fugitive dust emissions from ground disturbance. The quantity, duration, and intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations that occur at any one time. More emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Depending on the level of activities and amount of infrastructure built, construction of salinity source controls could exceed air quality thresholds established by SJVAPCD and would be required to implement measures to help reduce or minimize construction-related emissions. Lead agencies (e.g., CII facilities or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on air quality associated with construction emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the regulatory requirement to implement all required feasible measures to • reduce emissions during construction and the potential for the duration and frequency of activities during construction to

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	reduce overall emissions (e.g., diluting emissions over time). • Prior to a project dealing with a stationary source of emissions (such as a CII facility), it is required to receive an ATC from SJVAPCD. The project is subject to the requirements of SJVAPD Rule 2201. As stated under Sections 1.1 and 1.2 of Rule 2201[24]: *The purpose of this rule is to provide for the following:* *1.1 The review of new and modified Stationary Sources of air pollution and to provide mechanisms including emission trade-offs by which Authorities to Construct such sources may be granted, without interfering with the attainment or maintenance of Ambient Air Quality Standards;* *1.2 No net increase in emissions above specified thresholds from new and modified Stationary Sources of all nonattainment pollutants and their precursors.* Rule 2201 applies to new stationary sources and all modifications to existing stationary sources that are subject to permit requirements and may emit one or more affected pollutant after construction. • Operation of salinity source controls could include facility inspection and maintenance activities, similar to the maintenance of existing CII facilities. Operation of salinity source controls would likely be electric because of their expected locations in urban and suburban areas and the expected location within the footprint of a CII facility. Salinity source controls may use nonelectric backup intermittently for emergency circumstances. Operations could include facility inspection and maintenance activities and are expected to be similar to or fewer activities than inspection and maintenance of existing wastewater treatment facilities. The need for additional energy could result in increased criteria pollutant emissions at other power facilities. However, the power facilities that would compensate for the additional power are already built and permitted to emit a maximum amount of criteria pollutants. These facilities are required to offset additional power generation by the use of pollution credit. Therefore, if additional emissions are generated, they would be generated by facilities that are permitted to do so. There would be an increased number of truck trips associated with the disposal of salt concentrate at landfills, and these trips would produce emissions. The number of truck trips would depend on the salinity of the wastewater, which is a function of the quality and volume of the influent and the CII process, which is unknown at this time, and therefore cannot be quantified in this analysis. However, depending on the amount of materials that would require disposal and number of haul trucks that would be required, operational activities associated with material hauling could result in exceedances of SJVAPCD's thresholds, as SJVAPCD's CEQA Guidelines indicate their numeric thresholds are project-level and cumulative: "Any proposed project that would individually have a significant air quality impact…would also be considered to have a significant cumulative air quality impact (SJVAPCD 2002)". This could result in a potentially significant impact. Lead agencies (e.g., CII facilities or municipalities) can and should implement potential mitigation

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[24] Sources whose primary function is permitted by SJVAPCD through Rules 2010 and 2201 are not subject to SJVAPCD Rule 9510 (Indirect Source Review). Projects subject to Rule 9510 are required to quantify and reduce indirect (mobile source emissions), area-source (space heating, landscaping, and maintenance), and construction exhaust emissions.

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	measures identified in Table 16-38 to reduce potentially significant environmental effects associated with operational emissions and air quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.
	• SJVAPCD generally defines a sensitive receptor as a facility that houses or attracts children, the elderly, people with illnesses, or others who are especially sensitive to the effects of air pollutants, and where there is a reasonable expectation of continuous human exposure according to the averaging period for National AAQSs (e.g., 24-hour, 8-hour, or 1-hour) (SJVAPCD 2002). Sensitive receptors are primarily concentrated in urbanized areas and their proximity to construction or operational activities, the type of activity, and duration of activity, determines their potential exposure to pollutants. If criteria pollutant standards are exceeded during construction, and sensitive receptors are in proximity, mitigation measures identified in Table 16-38 would serve to reduce potentially significant air quality effects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. It is not anticipated that operation of the facilities would expose sensitive receptors to substantial pollutant concentrations because operations would not generate toxic or diesel exhaust. If diesel generators were used, they would be limited in operation and would likely be subject to air district permitting requirements that would minimize health risks. Impacts on sensitive receptors related to operation of salinity source controls would be less than significant. • The ARB traditionally has established state air quality standards, maintaining oversight authority in air quality planning, developing programs for reducing emissions from motor vehicles, developing air emission inventories, collecting air quality and meteorological data, and approving State Implementation Plan, as required by the Clean Air Act provisions. Responsibilities of local air districts include overseeing stationary source emissions, approving permits, maintaining emissions inventories. SJVAPCD has adopted an air quality improvement plan that addresses NO_X and ROGs, both of which are ozone precursors and contribute to the secondary formation of PM10 and PM2.5. The plan specifies that regional air quality standards for ozone and PM10 concentrations can be met through the use of additional source controls and trip reduction strategies. It also establishes emission budgets for transportation and stationary sources. Those budgets, developed through air quality modeling, reveal how much air pollution can be present in an area before national AAQSs are violated. General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction and operation of salinity source controls would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with air quality plans if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air plans. The construction and operation of salinity source controls would not result in growth because it would serve to provide salinity source controls at different locations within a service district to reduce the overall salt loading into the sewer system and would not serve to satisfy an increase in demand or an increase in need. The construction and operation of salinity source controls would not result in population or employment growth that would result in a conflict

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	with or obstruct implementation of the applicable air quality plan because they would not require activities that are associated with population growth (e.g., housing development, business centers, etc.). Accordingly, this impact is less than significant. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). While salinity source controls may be applied at one or more of these types of facilities, the salinity source controls would not contribute to any odors that would already be produced by the facilities. This is because the salinity source controls take the facilities' source water or wastewater and remove salt. Therefore, construction and operation of salinity source controls would not create objectionable odors affecting a substantial number of people. Impacts would be less than significant.
Biological Resources	• It is expected that construction and operation of salinity source controls would be in urban and suburban areas within the footprint of existing CII facilities. These areas are expected to have a low potential for candidate, sensitive, or special-status species, and habitat (including federally protected wetlands, riparian habitat, or other sensitive natural communities) because urban and suburban areas typically have buildings and impervious surfaces and would be very unlikely to support these biological resources. Because of their location, construction and operation of salinity source control facilities are unlikely to interfere with the movement of any native resident or migratory fish or wildlife species, or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. Furthermore, it is expected that the treated effluent discharged from the WWTP would actually have lower concentration of salts due to the salinity source controls, and this would be beneficial to aquatic and other biological resources. If candidate, sensitive, or special-status species or habitats are identified within close proximity, Table 16-38 lists potential mitigation measures lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant environmental impacts on biological resources related to construction and operations of salinity source control facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the low potential for sensitive species and habitat to exist and the relatively short timeframe and duration of construction. • It is unlikely construction and operation of salinity source controls would conflict with local policies or ordinances protecting biological resources, or conflict with an adopted natural community conservation plan or habitat conservation plan because construction and operation would likely occur within existing facilities. However, construction and operation of salinity source control facilities would occur within the SJMSCP Plan Area. The SJMSCP is administered by the SJCOG, a non-profit corporation established by San Joaquin County and the cities of Escalon, Lathrop, Lodi, Manteca, Ripon, Stockton and Tracy. Implementation of new salinity source controls may be considered a covered activity under SJMSCP—a determination which would be made by SJCOG, in consultation with the lead agency. If an activity is determined to be covered, participation in the SJMSCP is voluntary except when conditioned to participate by a Permittee (i.e., SJCOG, Inc. San Joaquin County, and the cities of Escalon, Lathrop, Lodi, Manteca, Ripon, Stockton and Tracy). If an activity is not covered,

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	the lead agency can request coverage using one of the following four options: (1) payment of a fee, which is assessed depending on habitat type within which the project is located; (2) dedicate habitat lands as a conservation easement or fee title; (3) purchase mitigation bank credits from a SJCOG-approved mitigation bank; and (4) propose an alternative mitigation plan, consistent with the goals of the SJMSCP and equivalent in biological value. Participation in the SJMSCP fulfills ESA, CESA, NEPA, and CEQA requirements, provides mitigation and guarantees no additional mitigation, excepting for Incidental Take Minimization Measures required in limited cases (SJCOG 2016a). If the lead agency participates in the SJMSCP, construction and operation of salinity source control facilities would not be considered in conflict with the SJMSCP, and impacts would be less than significant. If the lead agency chooses to opt out of participation in the SJMSCP, that agency or agencies (e.g., municipalities or municipal water purveyors) can and should implement the mitigation measures identified in Table 16-38 to reduce potentially significant impacts on biological resources and to avoid conflict with the SJMSCP. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. If habitat is permanently removed as a result of constructing or operating salinity source control facilities, it is likely that impacts could not be mitigated and would remain significant and unavoidable. However, it is likely impacts could be reduced once mitigation was implemented because once a lead agency opts in or determines its action is covered, consistency would be determined and impacts would be less than significant. • The brine generated by salinity source controls would be disposed of at landfills, and would have a very low potential to affect biological resources because the brine would be contained within the landfill. Impacts would be less than significant.
Cultural Resources	• Construction and operation of salinity source control facilities would likely exist in urban and suburban areas within existing CII facilities. Construction may result in some ground-disturbing activities, which has the potential to disturb or destroy buried, unknown significant cultural resources (significant historical, archeological, or paleontological resources). While it is unknown if cultural resources exist in these locations, these areas would have likely been previously disturbed during the construction of the existing CII facilities, reducing the potential for significant unknown cultural resources to exist. Operation of salinity source controls has no potential to affect cultural resources because the facilities would simply remove salt and discharge wastewater of lower salinity into the sewer system. Lead agencies (e.g., CII facilities or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on cultural resources associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the low potential for cultural resources to exist and the relatively limited area of ground disturbance. • As described above, it is expected the CII facility locations would be previously disturbed. If, in the highly unlikely event human remains are uncovered during construction, compliance with the State Health and Safety Code would be required. As specified by Section 7050.5 of the Health and Safety Code, and described in Table 16-38, no further disturbance shall occur until the county coroner has made the necessary findings as to origin and disposition pursuant to Public Resources Code, Section 5097.98. If such a discovery occurs, excavation or construction shall halt in the area of the discovery, the

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	area shall be protected, and consultation and treatment shall occur as prescribed by law. If the coroner recognizes the remains to be Native American, he or she shall contact the NAHC, who shall appoint the Most Likely Descendent. Additionally, if the human remains are determined to be Native American, a plan shall be developed regarding the treatment of human remains and associated burial objects, and the plan shall be implemented under the direction of the Most Likely Descendent. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the low potential for human remains to exist and the relatively limited area of ground disturbance.
Geology and Soils	• Salinity source controls would not result in an impact on, or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, or landslides. Since the facilities would be located within existing CII facilities, the addition of the salinity source controls would not substantially add to the structure such that it would increase the exposure to potential substantial adverse effects, such as risk of loss to rupture of known earthquake fault, seismic ground shaking, or seismic ground-related failure. Furthermore, all new structures related to salinity source controls would be required to follow all appropriate building codes and be designed to withstand seismic-related activities as identified by the building codes. Finally, salinity source controls would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would be less than significant. • The construction and operation of salinity source controls would not involve constructing or operating septic tanks and, therefore, septic tanks would not be affected by soils incapable of supporting the use of them or other alternative wastewater disposal systems. Impacts would not occur. • Construction of salinity source control facilities could result in limited ground-disturbing activities, which could cause soil erosion or loss of topsoil; however, ground-disturbing activities would be limited in duration and geography and would most likely be contained within the site of an existing CII facility. Furthermore, ground-disturbing activities of 1 acre or greater would need the preparation and implementation of a SWPPP as required by the Central Valley Water Board. The SWPPP would require soil and erosion control mechanisms. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts related to soil erosion and storm water runoff and erosion associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented due to the temporary nature of construction and the relatively small scale of disturbance within or adjacent to an existing facility.

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Greenhouse Gas Emissions	• Similar to the discussion in Table 16-7, because construction and operation of salinity source control facilities would likely result in increased use of electricity and fuels and there would be an increase in GHG emissions. Depending on the process used (e.g., RO) salinity source controls could be an energy-intensive process (e.g., RO energy use will vary depending on the salinity and temperature of the source water or wastewater; the higher the salinity or the colder the water temperature, the more energy it takes to remove the salt [Kennedy/Jenks Consultants 2013]). The overall increased electrical load would be extremely small compared to the existing electrical load of the service area and it is unlikely to require the construction of major new power generation or transmission facilities. However, it is anticipated that this increased electricity-related GHG emissions could exceed applicable SJVAPCD ZEL thresholds and result in a potentially significant impact. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

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Resource	Discussion
Hazards and Hazardous Materials	• Construction of salinity source controls would be short term in nature and may involve the limited transport, storage, use, and disposal of hazardous materials such as fuel and lubricating grease for motorized heavy equipment. Some examples of typical hazardous materials handling are fueling; servicing construction equipment on the site; and transporting fuels, lubricating fluids, solvents, and bonding adhesives. These types of materials are not acutely hazardous, and all storage, handling, and disposal of these materials are regulated by local, county, and state laws. Furthermore, the quantities of these materials used during construction would be small (e.g., less than 100 gallons) because construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction and the small amount of hazardous materials handled, used, or transported over the course of construction. • There are eight sites within San Joaquin County that are identified on the Hazardous Waste and Substance Site List (Cortese Site list) as being hazardous materials sites under Government Code, § 65962) (CalEPA 2016). Construction and operation of salinity source controls is not likely to be located on these eight sites or interfere with these sites because these sites are not CII facilities (e.g., commercial laundry facilities, food processing operations, and industrial fabrication shops) (CalEPA 2016). CalEPA identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facility sites where DTSC has taken corrective action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action in San Joaquin County (CalEPA 2016). As such, construction and operation of salinity source controls could not affect them. There are approximately 244 leaking underground storage cases in San Joaquin County designated as open (CalEPA 2016). Sixteen facilities in San Joaquin County have received CDOs or CAOs and have active cases, but may not be necessarily related to hazardous waste (CalEPA 2016). Some of these locations could be classified as CII facilities and may decide to implement salinity source controls (e.g., commercial laundry facilities, food processing operations, and industrial fabrication shops). During construction ground disturbing activities potentially contaminated soil could be encountered. As such, Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • San Joaquin County has 14 school districts and more than 200 schools (San Joaquin County Office of Education n.d.). The location of construction of salinity source controls is unknown; however, construction could be located within one-quarter mile (0.25 miles) of a school. Hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected these would be handled, used, and stored properly in accordance with local, state, and federal laws, and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school.

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	Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation activities. As such, if a school existed within close proximity to a construction site, those mitigation measures identified table 16-38 applied to project-specific construction needs would reduce potentially significant impacts during construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • Operation of salinity source controls would not produce any new wastewater that would not already be produced and discharged to the sewer system and ultimately treated at the WWTP. If municipal wastewater already contains constituents, they should not be hazardous due to pretreatment requirements with which CII facilities must comply. Therefore, when compared to baseline, no new quantities of hazardous materials would be used, transported, or disposed of. There could be a new waste stream (e.g., salt concentrated waste) generated from the CII facility that would need to be removed and disposed of in accordance with applicable laws and regulations. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during operation. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the need to comply with state and federal regulations in order to conduct business and operate. • Assuming construction and operation of salinity source control measures would be located in San Joaquin County, there are six public access airports within the county (SJCOG n.d.[a]). The Stockton Metropolitan Airport and San Joaquin County Airport have approved Airport Land Use Compatibility Plans, which prescribe safety requirements and ensure land uses would not pose a safety hazard to the airports in accordance with the Federal Aviation Administration. Other airports, such as the City of Tracy, have either airport master plans or other planning documents outlining safety requirements and ensuring land uses would not pose a safety hazard, consistent with FAA requirements (City of Tracy 1998). The location of the CII facilities that may implement salinity source controls is unknown and these facilities could be located within 2 miles of an airport. However, construction and operation of salinity source controls would not be a hazard or provide a safety concern to airports since salinity source controls would be constructed and operated within the footprint of existing CII facilities and the CII facilities already exist. Impacts would not occur. • Construction and operation of salinity source controls would not physically interfere with an adopted emergency response plans or emergency evacuation plans since they would be located within exiting CII facilities and would not prohibit the mobility of people to escape potential emergencies. Furthermore, construction and operation does not involve an increase in population that would necessitate reconsideration of how to evacuate people in an emergency. Impacts would not occur. • Construction and operation of salinity source controls would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur.

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Hydrology and Water Quality	• Construction of salinity source controls could result in temporary changes to storm water drainage, existing drainage patterns, erosion, or runoff associated with typical construction activities, such as grading or preparation of land. As discussed earlier in this table (Geology and Soils section), for soil disturbance of over 1 acre, wastewater treatment special districts or municipalities would be required to prepare and implement a SWPPP, which would include specific types and sources of storm water pollutants, determine the location and nature of potential impacts, and specify appropriate control measures to eliminate any potentially significant impacts from storm water runoff on receiving waters. In addition, as discussed in this table for Hazards and Hazardous Materials, construction of salinity source controls may involve the limited transport, storage, use, and disposal of hazardous materials, which, if spilled, could have adverse effects on water quality depending on the location and magnitude of the spill. However, storage, handling, and disposal of these materials is regulated by local, county, and state laws, and the quantities of these materials used during construction would be small (e.g., less than 100 gallons) and construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained and, as such, violations of water quality standards are not expected to occur. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary and the need to follow existing regulations requiring the handling, use and disposal of hazardous materials and the need to prepare SWPPPs. • It is unknown if CII facilities implementing salinity source controls would be located in a 100-year flood hazard area. However, since salinity source controls would be located within an existing CII facility footprint, the addition of salinity source controls would not substantially add to the existing structures such that flood flows would be impeded or redirected. Furthermore, salinity source controls would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to flood hazard locations or result in the construction of housing in a flood hazard area. Accordingly, salinity source controls would not expose people to significant loss, injury, or death related to flooding. Construction of salinity source controls would not result in flooding or otherwise cause flooding, including flooding as a result of the failure of a levee or dam. Impacts would be less than significant. • Under operating conditions, CII facilities would continue to discharge pretreated wastewater into the sewer and would have to comply with the pretreatment requirements of the receiving WWTP. The pretreatment requirements are in place such that the WWTP can meet the WDRs of its NPDES permit. While there could be an exceedance in wastewater treatment effluent by a CII facility due to an unforeseen circumstance, it would not be expected under normal operating procedures. Salinity source controls would not increase the volume of wastewater discharged from the CII facility but rather would reduce the salinity of the facility’s wastewater discharged into the sewer system. Therefore, it is expected that hydrology or water quality would not be affected as the CII facilities’ pretreated wastewater would have the same volume but lower salt concentration. Impacts would be less than significant.

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	• Salinity source controls would likely not result in the need for new storm water facilities because there is a low likelihood of new impervious surfaces being created as salinity source controls would likely be located in existing CII facility footprints. Impacts would be less than significant. • Increases in groundwater pumping are not expected under the construction and operation of salinity source controls because these types of control measures would not need to pump groundwater. Further, CII uses that would employ salinity source control already receive their source water from municipal sources and would not increase their demand. Therefore, groundwater supplies would not be substantially depleted. Construction of salinity source controls would not interfere with groundwater recharge because the controls would generally be within existing facility footprints. Impacts would be less than significant. • Construction and operation of salinity source controls would primarily be located in areas of relatively flat relief because they would be within the footprint of existing CII facilities, and these facilities typically are not located on the side of steep slopes. Therefore, these locations would not support mudflows, which typically need very steep slopes and large amounts of precipitation to occur. Furthermore, these areas would not be adjacent to the ocean and would not be affected by tsunamis. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction and operation of salinity source controls are not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of salinity source controls could result in a substantial degradation to water quality.
Land Use and Planning	• Construction and operation of salinity source controls would not physically divide an established community because they would likely be located in the existing footprint of CII facilities. Impacts would be less than significant. • Construction and operation of salinity source controls would take place on the footprint of existing CII facilities and would not conflict with land use designations or zoning because the CII facilities are allowed generally to update or modify their facilities and processes within their appropriate land use and zoning designations. Impacts would be less than significant. If the salinity source controls were inconsistent with applicable land use plans, policies, or regulations, an amendment or variant from the local jurisdiction approving the discretionary action associated with the salinity source controls would be required to be obtained by the project proponent prior to project approval and construction. If no discretionary action occurred as a result of the construction or operation of the salinity source controls, it is assumed it would not result in a conflict with local land use plans, policies, or regulations. Impacts would be less than significant. • Construction and operation of salinity source controls would likely take place in the Delta and may be considered covered activities under the Delta Plan. Only the lead CEQA state or local agency may determine whether that plan, program, or project is a covered action of the Delta Plan. If an action is covered, consistency with the Delta Plan would be determined. The consistency determination would include implementing mitigation from the Mitigation Monitoring or Reporting Program of the Delta Plan, as appropriate. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts

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Resource	Discussion
	related to consistency with the Delta Plan. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely impacts could be reduced once mitigation was implemented because once a lead agency determines an action is covered and complies with the Mitigation Monitoring or Reporting Program, consistency would be determined and impacts would be less than significant. • Potential conflicts with habitat conservation plans, natural community conservation plans, or other plans, policies and regulations protecting biological species and resources are evaluated in the Biological Resources section of this table.
Mineral Resources	• The California SMARA requires the State Geologist to classify land into MZs, according to the known or inferred mineral potential of existing land. The primary goal of mineral land classification is to ensure that the mineral potential of land is recognized by local government decision-makers and considered before land-use decisions are made that could preclude mining. Local general plans, specific plans, and other local plans refer to, and use the information produced by the State Geologist, to identify mineral resources because they are specialized evaluations and because the California Geologic Survey is the designated agency to perform these surveys under SMARA. Some gravel, sand, and aggregate resources are found in close proximity to waterways and the LSJR in San Joaquin County (San Joaquin County 1998, City of Tracy 2005). Most of the city of Stockton is designated as either not having mineral resources or a low likelihood of mineral resources (City of Stockton 2007). Other mineral resources, such as gold or peat, have been previously extracted from the county (San Joaquin County 1998). • Construction and operation of salinity source controls would have a very low potential to result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally designated mineral resource recovery site. This is because salinity source controls would be within existing CII facilities, which are typically not located in the middle of mineral resource extraction areas. Furthermore, if the CII facilities are located within a state or locally designated mineral resource area, construction and operation of salinity source controls would not permanently remove access to a mineral resource as there would be other locations around the facilities that could provide access to the mineral resource. Impacts would be less than significant.
Noise	• Construction of salinity source controls would potentially take place in San Joaquin County, and the Cities of Tracy and Stockton depending on the location of the facilities that may implement salinity source control. Each of these jurisdictions have noise requirements in their general plans or zoning ordinances for construction and operation based on land use designations and timing restrictions. Noise requirements are typically based on land uses that are considered more sensitive to ambient noise levels than others due to noise exposure. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and outdoor recreation or natural areas are typically more sensitive to noise than are commercial or industrial land uses. Therefore, local noise standards are typically more stringent for sensitive land uses in terms of level of noise generated, duration, and frequency than less sensitive uses. Given the wide ranges of land uses throughout San Joaquin County, noise levels can range from louder high density residential and industrial uses or roadway uses to more quiet open space and agricultural areas (San Joaquin County 1992). Frequently, the most common and loud noise generating activity in San Joaquin County affecting the overall permanent ambient noise setting is freeway traffic on I-

Potential Environmental Effects of Salinity Source Controls

Resource	Discussion
	5, I-205, and SR-4 and along railroads and in heavy industrial areas (e.g., Port of Stockton) or around airports (San Joaquin County 1992). • The City of Tracy and the City of Stockton regulate generation of construction noise by restricting the timing that construction can occur (e.g., operating construction requirement from 10pm to 7pm is prohibited) and the land use or adjacent land uses under which the noise generating activity occurs (City of Stockton n.d., City of Tracy n.d.). San Joaquin County exempts noise sources associated with construction, provided they do not take place before 6am or after 9pm (San Joaquin County n.d.). Construction of salinity source controls could generate temporary noise and as such could expose people to noise levels in excess of standards. It is likely salinity source controls would be constructed in areas with suitable land use designations and zoning for CII uses because they would be within the footprint of existing CII facilities; therefore, it would be unlikely that sensitive receptors (e.g., homes, hospitals, schools) would be within close proximity. If sensitive receptors were adjacent to construction activities and experienced a temporary increase in ambient noise levels due to construction, construction would likely be temporary and would be required to follow existing local noise ordinances limiting the timing of construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts related to noise. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because construction impacts would be temporary and the low potential for sensitive receptors to be located within proximity to CII facilities. • Construction activities that typical result in ground-borne vibrations or ground-borne noise are activities such as pile driving, where the ground is repeatedly struck and vibrations or noise can be generated. Given the limited nature of the facilities being constructed for salinity source controls, it is unlikely that pile driving would be used. This is because these controls would be installed within existing facilities to the water supply connection or wastewater discharge to capture and treat the water either prior to the CII process or capture and treat it prior to discharge into the sewer system. As such, it would likely require finer mechanical installation than pile driving. Impacts would be less than significant. • The operation of salinity source controls may generate temporary noise when the CII facility is running. However, the existing facilities may already generate intermittent process noise (e.g., from alarm bells, pumps, and generators). Furthermore, it is anticipated there would be a very low probability that sensitive receptors (e.g., homes, hospitals, schools) would be located within close proximity to experience the operating noise generated because it is anticipated that the CII facilities would be located in areas with similar land uses (e.g., other CII facilities). Finally, it is expected that the salinity source controls would be enclosed within the CII buildings or enclosed with security fencing or barriers, which would reduce the operating noise. As such, a permanent increase in ambient noise under operating conditions is not expected. Impacts would be less than significant. • Assuming construction and operation of salinity source controls would be located in San Joaquin County, there are six public access airports within the county (SJCOG n.d.[a]). The Stockton Metropolitan Airport, San Joaquin County Airport have approved Airport Land Use Compatibility Plans, which identifies noise contours and where noise exposures may take place as a result of aircraft flight patterns consistent with Federal Aviation Administration requirements (SJCOG n.d.[a]).

Potential Environmental Effects of Salinity Source Controls

Resource	Discussion
	Other airports, such as the City of Tracy, have either airport master plans or other planning documents that outline noise contours consistent with FAA requirements (City of Tracy 1998). While it is unknown where construction or operation of salinity source controls might occur, the construction and operation of salinity source controls would not bring new or additional people within close proximity to an airport or private airstrip or expose people to noise generated by air traffic on a regular basis. This is because salinity source controls would not result in an increased permanent work force cited within proximity to an airport or private airstrip. Nor would salinity source controls result in a population increase that would be exposed to airport noise. Impacts would not occur.
Population and Housing	• The construction and operation of salinity source controls would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Additionally, construction and operation of salinity source controls would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people to the southern Delta. Impacts would not occur. • The construction and operation of salinity source controls would not displace substantial numbers of people or housing, or necessitate the construction of replacement housing elsewhere because the facilities would be located in the existing footprint of CII buildings and not where people currently reside. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, parks, libraries, schools) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, the construction and operation of salinity source controls would not involve an increase in population or housing. In addition, these actions do not include proposals for new housing and would not generate students or increased demands for school services or facilities. Impacts would not occur.
Recreation	• An increase in use of existing recreational facilities is typically associated with a substantial increase in the population to accommodate new recreationists. Construction or operation of salinity source controls would not result in a substantial increase in population because it would not result in the development of housing or other population-inducing development (e.g., job centers). The purpose of the construction and operation of salinity source controls would be to comply with water quality objectives. Construction and operation of these facilities would satisfy existing demand, not meet new projected demand for wastewater treatment or water supply. Impacts would not occur. • Construction of salinity source controls would likely occur within the footprint of CII facilities. These facilities are typically located adjacent to other CII land uses, so it is unlikely recreational facilities would be located in areas where CII facilities currently exist. However, if recreational facilities were located within very close proximity to the salinity source controls, recreational facilities could be affected by noise levels or other temporary construction activities. If construction occurs within close proximity to existing recreational resources, Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to construction noise, traffic, or air quality if those types of impacts occur within close proximity. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than

Potential Environmental Effects of Salinity Source Controls	
Resource	Discussion
	significant once mitigation measures were implemented, depending on the construction timeframe and the location of potential sensitive receptors and recreational resources, and the need to implement existing regulatory requirements (e.g., feasible air quality emissions reduction measures). • Construction and operation of salinity source controls would not include recreational facilities, and would not require the construction or expansion of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Assuming the construction and operation of salinity source controls would be located within San Joaquin County, projects would be subject to the SJCOG Regional Congestion Management Plan (SJCOG 2016b). CII facilities may be located in urban and suburban areas, including the City of Tracy, the City of Stockton, and the County of San Joaquin, that could already experience some congestion. As described in the Regional Congestion Management Program, projects are subject to a tiered review process, unless exempt from CEQA or unless considered as part of a previously approved project (SJCOG 2016b). Projects that trigger 125 or more vehicle trips during weekday AM or PM peak-hours or 500 or more total vehicle daily trips on any day of the week would be required to perform a quantitative regional traffic analysis. The Regional Congestion Management Program provides for mitigation to reduce effects if trips occur at those levels. Trips that are exempted from the RCMP standards, and are removed from calculations of LOS standards under the RCMP include trips resulting from construction (SJCOG 2013). A total of 103 intersections have been designated as part of SJCOG Regional Congestion Management Program (SJCOG n.d.[b]). Designation of RCMP intersections allows for congestion monitoring and appropriately focuses attention at locations where operational constraints are typically experienced on arterial roadways (SJCOG n.d.[b]). Operation of salinity source controls would generate additional truck trips to dispose of the waste brine generated by the salinity source control process. The number of truck trips depends on the volume of wastewater treated per day and the salinity; therefore, the number of trucks that would be required is unknown. As discussed above, if a project exceeds the criteria established by the Regional Congestion Management Program on roads identified in that program (e.g., 125 or more vehicle trips during weekday AM or PM peak-hours or 500 or more total vehicle daily trips on any day of the week), mitigation would be applied through that program. The criteria are particularly high and generally applicable to development such as office parks, retail, or housing developments that would generate substantial numbers of trips. However, Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant transportation and traffic impacts related to operations, if indeed brine disposal resulted in exceedances of the Regional Congestion Management criteria. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented and consistency with the Regional Congestion Management Plan was determined. • Construction and operation of salinity source controls could result in some additional trips. It is unknown the number of construction and operational trips that might be needed and the location of these trips, but it is anticipated that construction would be relatively limited in duration. Typically, construction activities are exempt from local road trip thresholds because construction is considered temporary. However, depending on the quantity of trips and the duration, the temporary increased traffic during construction or the potential increase in operational trips associated with brine disposal could exceed local or regional road trip thresholds (either vehicle miles traveled or level of service, as discussed in Table 16-25, changes to the methodology and criteria for evaluations are occurring). Projects would be required to

Potential Environmental Effects of Salinity Source Controls

Resource	Discussion
	evaluate trip generating activities through the respective jurisdiction traffic impact analysis guidelines, depending on the location and number of trips generated (City of Stockton n.d.). Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant transportation and traffic impacts related to construction or operation. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction and because brine disposal trips could likely occur on an infrequent basis. • Construction of salinity source controls is not expected to result in hazards to, or on, roadways because they would primarily be constructed within existing footprints of facilities. Similarly, construction activities are not expected to conflict with public transit facilities, public bicycle facilities, or pedestrian facilities (e.g., sidewalks) because they would be constructed within existing footprints of facilities. The development of project-specific construction traffic management plans, as identified in Table 16-38 would reduce potentially significant impacts if hazards on the roadway were temporarily created during construction due to construction related activities. Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts of transportation and traffic related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant, given the low likelihood of occurring, and once mitigation measures were implemented because construction impacts would be temporary. • Similar to the discussion in the Hazards and Hazardous Materials section of this table, it is not expected that construction of salinity source controls would result in inadequate emergency access, given the location of the construction work would primarily within the existing footprint of CII facilities. As such, there is a low likelihood of interfering with emergency access. However, Table 16-38 lists potential mitigation measures that lead agencies (e.g., CII facilities or municipalities) can and should implement to reduce potentially significant impacts of transportation and traffic related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. It is likely that impacts could be mitigated to less than significant, given the low likelihood of occurring, and once mitigation measures were implemented because construction impacts would be temporary. • Construction and operation of salinity source controls would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and are not related to air traffic or airports. Impacts would not occur. • Operation of salinity source controls are not expected to result in a permanent substantial increase in hazards due to a design feature or incompatible use, permanent inadequacy of emergency access, or a permanent change that would decrease the performance or safety of public transit facilities, public biking facilities, or public pedestrian facilities because it is anticipated that these would be located within existing facility footprints. Trips associated with brine disposal would be done on existing roads and as such, would not result in permanent substantial hazards or conflicts with emergency access and public transit, bicycle, or pedestrian facilities. Impacts would be less than significant.

Potential Environmental Effects of Salinity Source Controls

Resource	Discussion
Utilities and Service Systems	• Construction and operation of salinity source controls would not be expected to affect wastewater treatment requirements of the Central Valley Water Board because it would actually reduce the salinity of the wastewater entering a WWTP. Therefore, the salinity source controls overall would reduce the salinity in the treated effluent that is discharged into receiving waters. Additionally, construction and operation of salinity source controls would not result in a determination by a wastewater treatment provider that it has inadequate capacity to meet the service area's demand because the salinity source controls would not increase the volume of wastewater from the CII facilities discharged into the sewer system; therefore, the WWTP would receive the same volume of wastewater. Impacts would be less than significant. • Construction and operation of salinity source controls would not require new entitlements because the controls would not require water. The controls target salinity in the wastewater collection system and implemented prior to wastewater entering the system to be treated. As such, impacts would not occur. • Construction and operation of salinity source controls would involve the construction of WWTP infrastructure. Environmental effects associated with the infrastructure are discussed earlier in this table (Aesthetics through Transportation and Traffic). Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant construction and operation impacts related to all environmental resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • The construction and operation of salinity source controls would not need the construction of additional storm water drains because they would likely be built within the footprint of the existing CII facilities, which currently have impervious surfaces that generate runoff. It is expected that existing storm water infrastructure would be used. Impacts would be less than significant. • Construction and operation of salinity source controls could generate solid waste in the form of waste brine. All waste would be disposed of in accordance with applicable laws and regulations. Impacts would be less than significant.

16.4.3 Desalination

Some wastewater treatment agencies may opt to remove salts at the WWTP before treated effluent is discharged to the southern Delta. Conventional wastewater treatment processes do not significantly remove salts from the wastewater. To remove salts, a discharger must desalinate treated wastewater effluent. Methods to desalinate water at WWTPs include thermal separation, electro-dialysis, and RO. This analysis is specific for RO because it is the most common desalination technology in California and is comparable or less expensive than other desalination methods (e.g., ion exchange, distillation) (DWR 2009). It is anticipated that the following municipalities and wastewater treatment service providers that discharge into the southern Delta could implement such programs: City of Tracy, City of Stockton, and Mountain House CSD.

Cost Evaluation

The costs of RO include the costs associated with the construction of the RO facilities and operation and maintenance costs associated with energy use and brine disposal. Brine's salinity is a function of the concentration and volume of the influent into the RO filter and the efficiency of the RO filter. For example, if the influent water had 75,000 pounds of salt per 10 mgd, and the RO filter was 85 percent efficient, the brine would contain 75,000 pounds of salt per 1.5 million gallons.

Brine disposal is an important consideration when evaluating wastewater treatment technologies used to reduce salinity. This is because of the associated costs and potential environmental effects of brine disposal. There are five major methods of brine disposal: (1) disposal to WWTPs, (2) disposal to surface waters, (3) deep-well injection, (4) evaporation ponds, and (5) evaporation to dryness (crystallization). Approximately 40 percent of all desalination facilities in the country discharge brine to an existing wastewater collection system (Sethi et al. 2006, USBR 2006c). Approximately 48 percent of all desalination facilities in the country discharge brine directly to surface water (Sethi et al. 2006, USBR 2006c). In some areas, brine may be discharged to a deep well, below potable water aquifers (TWDB 2009). Regulatory concerns associated with this deep-well injection method of brine disposal include the receiving water's transmissivity, the salinity of the receiving water, and the presence of a structurally isolating and confining layer between the receiving aquifer and any overlying source of drinking water (Sethi et al. 2006, USBR 2006c). Evaporation ponds can be used in relatively warm, dry climates with high evaporation rates, level terrain, and low land costs (Sethi et al. 2006). Evaporation ponds allow the brine to dewater, and then be hauled to a landfill for ultimate disposal. Thermal separators and vapor compression systems can completely remove water from brine, leaving a crystallized solid for disposal. These crystallization systems are very energy intensive. The capital, operations, and maintenance costs can exceed the cost of the desalination facility. This potential brine disposal method is used for very small flows where other discharge methods are not feasible (Sethi et al. 2006). Other methods that have been utilized are treatment wetlands and other developing technologies (TWDB 2009).

Evaporation ponds were selected for this cost evaluation because of their lower associated cost and regulatory constraints. The assumptions included in the cost evaluation are a portion or all of the wastewater treated effluent would be treated with RO at the wastewater facility, the brine would be dewatered in evaporation ponds located at the wastewater facility or adjacent to the wastewater facility, and solids remaining after evaporation would be transported and disposed of at a Class I/II landfill (non-hazardous waste landfill).

The cost to install a desalination system at a WWTP is highly variable. In general, important factors to consider are the quality and quantity of wastewater effluent entering the desalination system, the desired quality leaving the desalination system, energy costs, the chosen method of desalination, and the brine disposal method. Some WWTPs will only need to treat a portion of the wastewater effluent to achieve effluent limitations for salinity, which would reduce costs.

The California Water Plan Update 2009 discusses the cost of desalination. Table 16-29, *California Water Plan Update 2009 Unit Cost of Desalination*, provides a summary of costs.

Table 16-29. California Water Plan Update 2009 Unit Cost of Desalination

	Total Water Cost ($/AF)	
Type of Desalting	Low	High
Groundwater	$500	$900
Wastewater	$500	$2,000
Seawater	$1,000	$2,500

Source: DWR 2009.
AF = acre-feet.

Using this approximation, a 10 mgd discharger can expect to pay $5.6–$22.4 million to construct an RO system at the WWTP. Extrapolating this trend is nonlinear. The associated administrative, engineering, and legal costs do not generally decrease for smaller projects. Larger RO facilities cost more, but the typical unit price of water produced decreases due to the scale of construction costs compared to administrative, engineering, and legal costs.

Environmental Evaluation

Summary of Potential Action

The location, timing of construction, and details of operation of desalination facilities are unknown. In addition, the size and scale of the facilities is unknown. These unknown factors would influence the type, magnitude and severity of impacts that could occur during construction and operation. However, any modified or new desalination facilities would likely be constructed and operated in the existing footprint of, or within very close proximity to, a WWTP that discharges treated effluent into the southern Delta waterways or is physically located within the southern Delta. This is because the desalination process would have to be integrated with the wastewater treatment stream to capture the WWTP treated effluent, remove the salt, and release the RO effluent into receiving waters. Additionally, it is assumed WWTPs are located within close proximity to creeks or rivers because they must discharge treated effluent into receiving waters. It is also assumed WWTPs are located in more urbanized areas and adjacent to CII and urban uses because they must be located in an area to serve their existing municipal customers. Treatment plants are generally located on lands designated and zoned for public facilities and CII uses. Desalination would likely require the disposal of highly concentrated salt waste streams (e.g., brine). These waste streams are assumed to be trucked offsite and disposed of in a landfill for nonhazardous materials. Since the operation of the desalination facilities would be located within existing WWTPs or within close proximity, and the process is highly automated, it is anticipated that the current employees of the existing WWTP would maintain and operate the desalination facility and that a substantial number of additional employees would not be needed.

Potential Environmental Effects

Construction of wastewater desalination facilities would likely result in temporary and highly localized effects typically associated with similar activities, including air quality effects and ground disturbance. As noted above, it is likely that such facilities would be constructed in areas that are already disturbed by urban development, and most facilities would be located within existing WWTP footprints. Desalination facilities are typically relatively energy intensive. However, the overall increased electrical load for new treatment facilities would be very small compared to the existing electrical grid capacity and is unlikely to require the construction of major new power generation or transmission facilities. The operation of new RO treatment facilities may require a slight increase in chemical transport and storage, but this potential increase would likely be minimal because new RO facilities would likely be constructed within or adjacent to existing WWTPs. Therefore, the increase would be negligible compared to existing chemical use and transport.
New desalination facilities would result in the production of solid waste, which would be disposed of in accordance with applicable laws and regulations in landfills. To the extent such programs were successful in reducing salinity in the southern Delta, agricultural uses and aquatic resources would benefit. Construction and operation of such facilities are highly regulated, and the project would be required to comply with applicable regulations. In addition, because such facilities are owned by WWTP service districts[25] and subject to CEQA review, any new projects would undergo project-level analysis under CEQA and other required regulatory compliance at the time they are proposed.

Table 16-30, *Potential Environmental Effects of Wastewater Treatment Plant Desalination*, summarizes the potential environmental effects associated with desalination. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, at the end of this chapter lists potential mitigation measures associated with the construction or operation of the methods of compliance and is referenced in Table 16-30 where appropriate.

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[25] Note: Cities or water districts that do not treat wastewater would have no obligation to try to reduce the salt levels in the water they provide.

Table 16-30. Potential Environmental Effects of Wastewater Treatment Plant Desalination

Potential Environmental Effects of Wastewater Treatment Plant Desalination	
Resource	Discussion
Aesthetics	• Construction and operation of WWTP effluent desalination facilities would not be expected to substantially degrade the visual character or quality of areas where these facilities would be constructed, or substantially damage scenic resources (including trees, rock outcroppings, and historic buildings) within the state-designated scenic highways in San Joaquin County (I-5 and I-580) because desalination facilities would be located within the existing footprint of WWTPs or within close proximity. These facilities would be similar in size, scale, and general appearance as the existing WWTP. The magnitude and severity of the aesthetic impacts would depend on the location of sensitive receptors and scenic vistas relative to the construction and operation site. For example, San Joaquin County has no designated scenic vistas and as such an impact may not occur (San Joaquin County 2014a). Construction of the facilities could create temporary light and glare during potentially needed nighttime construction periods, and once desalination facilities become operational, they may require permanent outdoor lighting. However, given that these facilities would likely be located within an existing WWTP footprint or within close proximity, it is unlikely that this light and glare would be substantial relative to existing outdoor lighting conditions. Impacts on aesthetic resources would depend on the location of sensitive receptors relative to potential lighting. Outdoor lighting would be expected to follow lighting guidelines and plans of local jurisdictions approving the construction and operation of the desalination facilities. Table 16-38 identifies potential mitigation measures lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant environmental effects associated with light and glare and aesthetics. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the potential location of possible sensitive receptors and the ability to reduce light and glare.
Agriculture and Forestry Resources	• Construction and operation of desalination facilities would not be expected to take place on lands used for agriculture (Prime Farmland, Unique Farmland or Farmland of Statewide Importance) or on lands under Williamson Act contract because the facilities would be located within the footprint of existing WWTPs or within very close proximity such that the desalination facilities can use the existing wastewater treatment stream. Additionally, it is expected that agricultural uses in the southern Delta would benefit from the reduction in salinity and potentially offset any losses of agricultural land that might be indirectly affected by the desalination facilities. Table 16-38 identifies potential mitigation measures lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant environmental effects on agricultural resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of

Potential Environmental Effects of Wastewater Treatment Plant Desalination	
Resource	Discussion
	potential disturbance during construction. It is also expected that desalination would result in higher water quality in the southern Delta, which could potentially offset impacts on agricultural land affected by the recycled water facilities. • Construction and operation of desalination facilities would not be expected to take place forest lands or timberland because the facilities would be located within the footprint of existing WWTPs or within very close proximity such that the desalination facilities can use the existing wastewater treatment stream. Furthermore, the southern Delta generally does not have timber resources or forestlands. As such, there would be no conflict with existing zoning for forest land or timberland, and there would be no rezoning or loss of these resources. Impacts would not occur.
Air Quality	• Desalination facilities would likely be located in the SJVAB, which generally covers San Joaquin, Stanislaus, Merced, and Madera Counties. USEPA has classified SJVAB as an extreme nonattainment area for the federal 8-hour ozone standard and a nonattainment area for the federal PM2.5 standard. For the federal CO standard, USEPA has classified most major population centers of the SJVAB as maintenance areas and rural areas of the SJVAB as unclassified/attainment areas. The SJVAB is classified as a serious maintenance area with regards to the federal PM10 standards. ARB has classified the SJVAB as a severe nonattainment area for the state 1-hour ozone standard and a nonattainment area for the state 8-hour ozone, PM10, and PM2.5 standards. ARB has classified the SJVAB as an attainment area for the state CO standard. SJVAPCD's published guidelines, *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002) do not require the quantification of construction emissions. Rather, the guidelines require implementation of effective and comprehensive feasible control measures to reduce PM10 emissions (SJVAPCD 2002). SJVAPCD considers PM10 emissions to be the greatest pollutant of concern when assessing construction-related air quality impacts and has determined that compliance with its Regulation VIII, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), constitutes sufficient mitigation to reduce construction-related PM10 emissions to less-than-significant levels and minimize adverse air quality effects. All construction projects must abide by Regulation VIII. Since the publication of the SJVAPCD's guidance manual, the district has revised some of the rules comprising Regulation VIII. Guidance from SJVAPCD staff indicates that implementation of a Dust Control Plan would satisfy some requirements of SJVAPCD Regulation VIII (Siong pers. comm.). Further consultation with SJVAPCD staff indicates that, though explicit thresholds for construction-related emissions of ozone precursors are not enumerated in the *Guide for Assessing and Mitigating Air Quality Impacts*, SJVAPCD considers it a significant impact when construction or operational emissions of ROG or NO_X exceed 10 tons per year or if PM10 or PM2.5 emissions exceed 15 tons per year (Siong pers. comm.). SJVAPCD's CEQA Guidelines indicate their numeric thresholds are project-level and cumulative: "Any proposed project that would individually have a significant air quality impact…would also be considered to have a significant cumulative air quality impact (SJVAPCD 2002)" Construction of desalination facilities would likely result in emissions associated with construction equipment and construction worker vehicle trips as well as fugitive dust emissions from ground disturbance. The quantity, duration, and intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that

Potential Environmental Effects of Wastewater Treatment Plant Desalination

Resource	Discussion
	would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Depending on the level of activities and amount of infrastructure built, construction of desalination facilities could exceed air quality thresholds established by SJVAPCD and would be required to implement measures to help reduce or minimize construction-related emissions. Lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on air quality from construction-related emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Prior to a project dealing with a stationary source of emissions (such as a WWTP) it is required to receive an ATC from SJVAPCD. The project is subject to the requirements of SJVAPD Rule 2201. As stated under Sections 1.1 and 1.2 of Rule 2201[26]: *The purpose of this rule is to provide for the following:* *1.1 The review of new and modified Stationary Sources of air pollution and to provide mechanisms including emission trade-offs by which Authorities to Construct such sources may be granted, without interfering with the attainment or maintenance of Ambient Air Quality Standards;* *1.2 No net increase in emissions above specified thresholds from new and modified Stationary Sources of all nonattainment pollutants and their precursors.* Rule 2201 applies to new stationary sources and all modifications to existing stationary sources that are subject to permit requirements that may emit one or more affected pollutant after construction. The requirements of this rule would be in effect on the date the application is determined to be complete by the Air Pollution Control Officer shall apply to such application. Operation of desalination facilities would likely be electric because of their expected locations in urban and suburban areas and the expected location in close proximity to existing wastewater treatment infrastructure. They may use nonelectric backup for intermittent emergency circumstances. Operations could include facility inspection and maintenance activities and are expected to be similar to or fewer maintenance activities than inspection and maintenance of existing wastewater treatment facilities. The need for additional energy could result in increased criteria pollutant emissions at other power facilities. However, the power facilities that would compensate for the additional power are already built and permitted to emit a maximum amount of criteria pollutants. These facilities are required to offset additional power generation by the use of pollution credits. Therefore, if additional emissions

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[26] Sources whose primary function is permitted by SJVAPCD through Rules 2010 and 2201 are not subject to SJVAPCD Rule 9510 (Indirect Source Review). Projects subject to Rule 9510 are required to quantify and reduce indirect (mobile source emissions), area-source (space heating, landscaping, and maintenance), and construction exhaust emissions.

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	are generated, they would be generated by facilities that are permitted to do so. • The increased number of truck trips that would be associated with the disposal of brine at landfills would produce emissions. The brine would be dewatered in evaporation ponds and then transported offsite to landfills. The number of truck trips cannot be fully quantified because it would depend on the salinity of the wastewater, which is a function of the concentration, volume of the RO influent, and the time the brine would need to spend in the evaporation ponds. However, depending on the amount of materials that would require disposal and number of haul trucks that would be required, operational activities associated with material hauling could result in exceedances of SJVAPCD's thresholds and potentially result in a cumulatively considerable net increase in criteria pollutants for which SJVAB is in nonattainment, as SJVAPCD's CEQA Guidelines indicate their numeric thresholds are project-level and cumulative: "Any proposed project that would individually have a significant air quality impact…would also be considered to have a significant cumulative air quality impact (SJVAPCD 2002)". Impacts due to operation of the desalination facilities could result in potentially significant impacts. Lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on air quality associated with operational emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • SJVAPCD generally defines a sensitive receptor as a facility that houses or attracts children, the elderly, people with illnesses, or others who are especially sensitive to the effects of air pollutants, and where there is a reasonable expectation of continuous human exposure according to the averaging period for National AAQSs(e.g., 24-hour, 8-hour, or 1-hour) (SJVAPCD 2002). Sensitive receptors are primarily concentrated in urbanized areas and their proximity to construction or operational activities, the type of activity, and duration of activity, determines their potential exposure to pollutants. If criteria pollutant standards are exceeded during construction, and sensitive receptors are in proximity, mitigation measures identified in Table 16-38 would serve to reduce potentially significant air quality effects. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. It is not anticipated that operation of the facilities would expose sensitive receptors to substantial pollutant concentrations because operations would not generate toxic or diesel exhaust. If diesel generators were used, they would be limited in operation and would likely be subject to air district permitting requirements that would minimize health risks. • The ARB traditionally has established state air quality standards, maintaining oversight authority in air quality planning, developing programs for reducing emissions from motor vehicles, developing air emission inventories, collecting air quality and meteorological data, and approving State Implementation Plan, as required by the Clean Air Act, provisions. Responsibilities of local air districts include overseeing stationary source emissions, approving permits, maintaining emissions inventories. SJVAPCD has adopted an air quality improvement plan that addresses NO_X and ROGs, both of which are ozone precursors and contribute to the secondary formation of PM10 and PM2.5. The air quality improvement plan specifies that regional air quality standards for ozone and PM10 concentrations

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Resource	Discussion
	can be met through the use of additional source controls and trip reduction strategies. It also establishes emission budgets for transportation and stationary sources. Those budgets, developed through air quality modeling, reveal how much air pollution can be present in an area before AAQSs are violated. General plan assumptions of local jurisdictions inform local air quality plans. The exceedance of air quality thresholds, or the net increase of emissions, does not necessarily mean construction and operation of new source water supply facilities would be inconsistent with applicable air quality plans or local general plans. A project is deemed inconsistent with an air quality plan if it would result in population and/or employment growth that exceeds growth estimates included in the applicable air quality plan or local general plan, which, in turn, would generate emissions not accounted for in the applicable air quality plan emissions budget. Therefore, projects are evaluated to determine whether they would generate population and employment growth and, if so, whether that growth and associated emissions would exceed those included in the relevant air quality plan(s). The construction and operation of desalination facilities would not result in growth because it would serve to provide alternate low-salinity water source(s) to water users and would not serve to satisfy an increase in demand or an increase in need. The construction and operation of desalination facilities would not result in population or employment growth that would result in a conflict with or obstruct implementation of the applicable air quality plan because they would not require activities that are associated with population growth (e.g., housing development, business centers, etc.). Accordingly, this impact is less than significant.
	• SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants. Construction and operation of desalination facilities would not involve the type of facility identified by, for example, SJVAPCD, as a known odor source (SJVAPCD 2002). The desalination facilities would be located at the WWTP but would not produce additional odors beyond what currently may be produced at the WWTP. This is because the desalination process typically uses the existing volume of wastewater which is already treated to secondary or tertiary levels (as required by state law). The desalination process further processes the wastewater effluent. Therefore, the additional processing of the wastewater does not produce further odors as the odors are typically generated during primary treatment and biosolids production. Furthermore, many WWTPs contain any odors by enclosing primary treatment and biosolids production and by scrubbing odor-generating emissions. Consequently, it is expected desalination would not create objectionable odors affecting a substantial number of people. Impacts would be less than significant.

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Resource	Discussion
Biological Resources	• It is expected that construction and operation of desalination facilities would be in urban and suburban areas within the footprint of existing WWTPs. These areas are expected to have a low potential for candidate, sensitive, or special-status species, and habitat (including federally protected wetlands, riparian habitat, or other sensitive natural communities). Additionally, the footprints of WWTPs are expected to have a very low potential for special-status biological resources because typically WWTPs are industrial facilities with buildings and impervious surfaces, which would be unlikely to support these biological resources. As such, construction and operation of desalination facilities are unlikely to interfere substantially with the movement of any native resident or migratory fish or wildlife species, or impede the use of native wildlife nursery sites. Furthermore, it is expected that the treated effluent discharged from the WWTP would actually be improved from baseline conditions because the desalination facilities would remove salinity prior to discharge into the receiving water. This would be considered beneficial to aquatic resources. If special status species and habitat are present, construction could result in short term, temporary, indirect effects. Table 16-38 lists potential mitigation measures lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant environmental effects of construction and operations on biological resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction and depending on the ability to schedule construction for particular seasons and durations. • It is expected that construction or operation of desalination facilities would not result in a conflict with an existing local policies or ordinances protecting biological resources, or an adopted habitat conservation plan or natural community conservation plan. However, construction and operation of desalination facilities would occur within the SJMSCP Plan Area. The SJMSCP is administered by the SJCOG, a non-profit corporation established by San Joaquin County and the cities of Escalon, Lathrop, Lodi, Manteca, Ripon, Stockton and Tracy. Implementation of new desalination facilities may be considered a covered activity under SJMSCP—a determination which would be made by SJCOG, in consultation with the lead agency. If an activity is determined to be covered, participation in the SJMSCP is voluntary except when conditioned to participate by a Permittee (i.e., SJCOG, Inc. San Joaquin County, and the cities of Escalon, Lathrop, Lodi, Manteca, Ripon, Stockton and Tracy). If an activity is not covered, the lead agency can request coverage using one of the following four options: (1) payment of a fee, which is assessed depending on habitat type within which the project is located; (2) dedicate habitat lands as a conservation easement or fee title; (3) purchase mitigation bank credits from a SJCOG-approved mitigation bank; and (4) propose an alternative mitigation plan, consistent with the goals of the SJMSCP and equivalent in biological value. Participation in the SJMSCP fulfills ESA, CESA, NEPA, and CEQA requirements, provides mitigation and guarantees no additional mitigation, excepting for Incidental Take Minimization Measures required in limited cases (SJCOG 2016a). If the lead agency participates in the SJMSCP, construction and operation of desalination facilities would not be considered in conflict with the SJMSCP, and impacts would be less than significant. If the lead agency chooses to opt out of participation in the SJMSCP, that agency or agencies (e.g., municipalities or municipal water purveyors)

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Resource	Discussion
	can and should implement the mitigation measures identified in Table 16-38 to reduce potentially significant impacts on biological resources and to avoid conflict with the SJMSCP. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. If habitat is permanently removed as a result of constructing or operating desalination facilities, it is likely that impacts could not be mitigated and would remain significant and unavoidable. However, it is likely impacts could be reduced once mitigation was implemented because once a lead agency opts in or determines its action is covered, consistency would be determined and impacts would be less than significant. • Disposal of the brine generated by the desalination facilities would occur at landfills and would have a very low potential to affect sensitive biological resources because the brine would be contained in the landfill. Impacts would be less than significant.
Cultural Resources	• Construction and operation of desalination facilities would likely take place in urban and suburban areas adjacent or within close proximity to existing wastewater treatment facilities and infrastructure. Construction may result in some ground-disturbing activities which have the potential to disturb or destroy buried, unknown, significant cultural resources (significant historical, archeological, or paleontological resources). While it is unknown if cultural resources exist in these locations, these areas would likely have been previously disturbed during the construction of the existing wastewater treatment facilities, reducing the potential for significant unknown cultural resources to exist. Lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on cultural resources associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented the low potential for resources to exist. • Operation of desalination facilities have no potential to affect cultural resources because the facilities would simply remove salt, and discharge treated effluent into receiving waters. Under baseline conditions, discharges are already occurring and an increase in discharge would not occur. Impacts would be less than significant. • As described above, it is expected that wastewater treatment sites would have been previously disturbed. Therefore, it is highly unlikely that human remains, typically buried at depths of 6 ft, would be disturbed during construction. If, in the highly unlikely event human remains are uncovered during construction, compliance with the State Health and Safety Code would be required. As specified by Section 7050.5 of the Health and Safety Code, and described in Table 16-38, no further disturbance would occur until the county coroner has made the necessary findings as to origin and disposition pursuant to Public Resources Code Section 5097.98. If such a discovery occurs, excavation or construction would halt in the area of the discovery, the area would be protected, and consultation and treatment would occur as prescribed by law. If the coroner recognizes the remains to be Native American, he or she would contact the NAHC, who would appoint the Most Likely Descendent. Additionally, if the human remains are determined to be Native American, a plan would be developed regarding the treatment of human remains and associated burial objects, and the plan would be implemented under the direction of the Most Likely Descendent.

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Resource	Discussion
	Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the low potential for resources to exist.
Geology and Soils	• Desalination facilities could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, desalination facilities would not result in an impact on or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, expansive soils, or landslides. Since the facilities would be located within or in close proximity to existing WWTPs, the addition of the desalination facilities would not substantially add to the structure such that it would increase the exposure of the structure to potential substantial adverse effects, as the risk of loss to rupture of known earthquake faults, seismic ground shaking, or seismic ground-related failure. Furthermore, new structures would be required to follow all appropriate building codes and would be designed to withstand seismic-related activities as identified by the building codes. Finally, desalination facilities would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts related to geology and soils associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the need to follow the building code and other state and federal building requirements. • The construction and operation of desalination facilities would not involve constructing or operating septic tanks and, therefore, septic tanks would not be affected by soils incapable of supporting the use of them or other alternative wastewater disposal systems. Impacts would not occur. • Construction of desalination facilities would result in limited ground-disturbing activities that could cause soil erosion or loss of topsoil; however, ground-disturbing activities would be limited in duration and geography. Furthermore, ground-disturbing activities of 1 acre or greater would require the need for preparation and implementation of a SWPPP, as required by the Central Valley Water Board. The SWPPP would require soil and erosion control mechanisms. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts on soil erosion and storm water runoff associated with construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction.

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Resource	Discussion
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-7, because construction and operation of desalination facilities would likely result in increased use of electricity and fuels there would be an increase in GHG emissions. The desalination process is an energy-intensive process (e.g., RO energy use will vary depending on the salinity and temperature of the source water or wastewater; the higher the salinity or the colder the water temperature, the more energy it takes to remove the salt [Kennedy/Jenks Consultants 2013]). The overall increased electrical load would be extremely small compared to the existing electrical demand of the service area and it is unlikely to require the construction of major new power generation or transmission facilities. However, it is anticipated that this increased electricity-related GHG emissions could exceed applicable SJVAPCD ZEL threshold and result in a potentially significant impact. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts of construction and operations from GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

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Resource	Discussion
Hazards and Hazardous Materials	• Construction of desalination facilities would be short term and may involve the limited transport, storage, use, and disposal of hazardous materials such as fuel and lubricating grease for motorized heavy equipment. Some examples of typical hazardous materials handling are fueling and servicing construction equipment on the site, and transporting fuels, lubricating fluids, solvents, and bonding adhesives. These types of materials are not acutely hazardous, and storage, handling, and disposal of these materials are regulated by local, county, and state laws. Further, the quantities of these materials used during construction would be small (e.g., less than 100 gallons) because construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction. • Schools are not located within one-quarter mile of the WWTPs of Tracy, Stockton, or Mountain House CSD (California Department of Education 2016a, 2016b). As such, impacts would not occur. • There are eight sites within San Joaquin County that are identified on the Hazardous Waste and Substance Site List (Cortese Site list) as being hazardous materials sites under Government Code, § 65962) (CalEPA 2016). Construction and operation of desalination facilities is not likely to be located on these eight sites or interfere with these sites because these sites are not located on the WWTPs of Tracy, Stockton, or Mountain House CSD and are not located within close proximity (CalEPA 2016). CalEPA identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facility sites where DTSC has taken corrective Action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action in San Joaquin County (CalEPA 2016). As such, construction and operation of desalination facilities would not affect them. There are approximately 244 leaking underground storage cases in San Joaquin County designated as open (CalEPA 2016). Sixteen facilities in San Joaquin County have received CDOs or CAOs and have active cases, but may not be necessarily related to hazardous waste (CalEPA 2016). The location of construction and ground disturbing activities is anticipated to be within existing WWTPs or within close proximity. However, construction could occur within proximity to leaking underground storage tanks. In addition, Stockton WWTP is included on the list of cease and desist or clean up and abatement for domestic sewage and industrial purposes. As such, during construction of desalination facilities ground disturbing activities potentially contaminated soil could be encountered. As such, Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed.

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	• Operation of desalination facilities would not produce any new wastewater that would not already be discharged. Municipal wastewater is not expected to contain hazardous materials due to CII facility pretreatment requirements. Therefore, when compared to baseline, no new quantities of hazardous materials would be used, transported, or disposed. However, there would be a new waste stream (e.g., brine) generated from the WWTP that would need to be removed. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts associated with hazardous materials during operations. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented. • Assuming construction and operation of desalination would be located in San Joaquin County, there are six public access airports within the county (SJCOG n.d.[a]). The Stockton Metropolitan Airport and San Joaquin County Airport have approved Airport Land Use Compatibility Plans, which prescribe safety requirements and ensure land uses would not pose a safety hazard to the airports in accordance with the Federal Aviation Administration. Other airports, such as the City of Tracy, have either airport master plans or other planning documents outlining safety requirements and ensuring land uses would not pose a safety hazard, consistent with FAA requirements (City of Tracy 1998). While it is unknown where construction or operation of desalination might occur, the WWTPs for the City of Tracy and Stockton and Mountain House CSD are not located within 2 miles of an airport (SJCOG n.d.[a]). Further, construction and operation of desalination facilities would not be a hazard or cause safety concerns to airports since the facilities would be constructed and operated within the footprint of existing WWTPs or within close proximity. Impacts would not occur. • Construction and operation of desalination facilities would not physically interfere with an adopted emergency response plans or emergency evacuation plans since they would be located within existing WWTPs or in close proximity to them and therefore would not prohibit the mobility of people to escape potential emergencies. Standard practices and protocols with respect to emergencies that are currently implemented by the WWTPs would apply and desalination facilities would be incorporated into the standard practices and protocols. Furthermore, construction and operation does not involve an increase in population that would necessitate reconsideration of how to evacuate people in an emergency. Impacts would not occur. • Construction and operation of desalination facilities would not involve the construction of housing or an increase in population and would not expose people or structures to wildland fires. Impacts would not occur.

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Resource	Discussion
Hydrology and Water Quality	• Construction of desalination facilities could result in temporary changes to drainages, erosion, or runoff associated with typical construction activities, such as grading or preparation of land. As discussed earlier in this table (Geology and Soils section), for soil disturbance of over 1 acre, wastewater treatment special districts or municipalities would be required to prepare and implement a SWPPP, which would include specific types and sources of storm water pollutants, determine the location and nature of potential impacts, and specify appropriate control measures to eliminate any potentially significant impacts from storm water runoff on receiving waters. In addition, as discussed in this table for Hazards and Hazardous Materials, construction of desalination facilities may involve the limited transport, storage, use, and disposal of hazardous materials, which, if spilled, could have adverse effects on water quality depending on the location and magnitude of the spill. However, storage, handling, and disposal of these materials is regulated by local, county, and state laws, and the quantities of these materials used during construction would be small (e.g., less than 100 gallons) and construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained and, as such, violations of water quality standards are not expected to occur. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts of construction on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction. • It is likely that the desalination facilities would be located in a flood hazard area because wastewater treatment facilities are typically located adjacent to rivers and streams so they can discharge treated effluent into receiving waters. Since the desalination facilities would be located within the existing WWTP footprint (or in close proximity), the addition of the desalination facilities would not substantially add to the existing structures such that flood flows would be impeded or redirected. Additionally, the desalination facilities would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to flood hazard locations or result in the construction of housing in a 100-year flood hazard area. Accordingly, desalination facilities would not expose people to significant loss, injury, or death related to flooding. Construction of desalination facilities would not result in flooding or otherwise cause flooding, including flooding as a result of the failure of a levee or dam because it would not involve construction or operation of levees or dams. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given construction would be temporary and the need to comply with existing building code requirements if building in flood hazard areas were to occur. • Desalination in conjunction with the wastewater treatment process would not increase the volume of treated effluent discharged into receiving waters. This is because the amount of wastewater entering the facilities and

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Resource	Discussion
	leaving the facilities would be the same, and only salts would be removed. Therefore, it is expected that hydrology would not be affected. Desalination would ensure that the treated effluent released to surface waters would be of lower salinity, and support compliance with beneficial use standards, objectives, and WDRs of NPDES permits. Impacts would be less than significant. • Increases in groundwater pumping are not expected to occur under the construction and operation of desalination facilities because wastewater treatment facilities do not pump groundwater. Furthermore, it is anticipated that evaporation ponds would be lined such that salts could not enter the groundwater system. Therefore, construction and operation of desalination facilities would not substantially deplete groundwater supplies or interfere substantially with groundwater recharge. Impacts would be less than significant. • Construction and operation of desalination facilities would primarily be located in areas of relatively flat relief because they would be within the footprint of existing WWTPs or within relatively close proximity, and WWTPs typically are not located on the side of steep slopes. Therefore, these locations would not support mudflows, which typically need very steep slopes and large amounts of precipitation to occur. Furthermore, these areas would not be adjacent to the ocean and would not be affected by tsunamis. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction and operation of desalination facilities are not expected to occur near a lake or reservoir. Impacts would not occur. • There are no other ways in which construction or operation of desalination facilities could result in a substantial degradation to water quality.
Land Use and Planning	• Construction and operation of desalination facilities would not physically divide an established community because they would likely be located in the footprint of the existing WWTP or closely adjacent. Impacts would not occur. • Construction and operation of desalination facilities would likely take place within the footprint of an existing WWTP or within close proximity and therefore would not likely conflict with land use designations or zoning since WWTPs are typically located in areas that are for public facilities. Mountain House CSD WWTP is located in an area zoned for public facilities with a land use designation of “Public”. The WWTP for the City of Stockton is in an area zoned as “Port” and with a land use designation of “Industrial”, and the City of Tracy’s WWTP is located in a “Light Industrial” zone with a land use designation of “Public Facilities”. If the desalination facilities were inconsistent with applicable land use plans, policies, or regulations, an amendment or variant from the local jurisdiction approving the discretionary action associated with the desalination facilities would be required to be obtained by the project proponent prior to project approval and construction. If no discretionary action occurred as a result of the construction or operation of the desalination facilities, it is assumed they would not result in a conflict with local land use plans, policies, or regulations. Impacts would be less than significant. • Construction and operation of desalination facilities would likely take place in the Delta and may be considered covered activities under the Delta Plan. Only the lead CEQA state or local agency may determine whether that plan,

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Resource	Discussion
	program, or project is a covered action of the Delta Plan. If an action is covered, consistency with the Delta Plan would be determined. The consistency determination would include implementing mitigation from the Mitigation Monitoring or Reporting Program of the Delta Plan, as appropriate. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to consistency with the Delta Plan. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely impacts could be reduced once mitigation was implemented because once a lead agency determines an action is covered and complies with the Mitigation Monitoring or Reporting Program, consistency would be determined and impacts would be less than significant. • Potential conflicts with habitat conservation plans, natural community conservation plans, or other plans, policies and regulations protecting biological species and resources are evaluated in the Biological Resources section of this table.
Mineral Resources	• The California SMARA requires the State Geologist to classify land into MZs, according to the known or inferred mineral potential of existing land. The primary goal of mineral land classification is to ensure that the mineral potential of land is recognized by local government decision-makers and considered before land-use decisions are made that could preclude mining. Local general plans, specific plans, and other local plans refer to, and use the information produced by the State Geologist, to identify mineral resources because they are specialized evaluations and because the California Geologic Survey is the designated agency to perform these surveys under SMARA. MZs are identified by the State to identify inferred mineral potential of an area. Areas designated MZ-1 have adequate information to determine no significant mineral resources exist, or indicate a very low likelihood; areas designated MZ-2 have adequate information to identify significant mineral deposits or indicate a high likelihood of presence; and areas designated MZ-3 have inadequate information to determine significance of mineral deposits, but contain mineral deposits. Some gravel, sand, and aggregate resources (identified as MZ-1 or MZ-2) are found in close proximity to waterways and the LSJR in San Joaquin County (San Joaquin County 1998, City of Tracy 2005). Most of the city of Stockton is designated as MZ-1, with a small area of MZ-3 (City of Stockton 2007). Other mineral resources, such as gold or peat, have been previously extracted from the county (San Joaquin County 1998). • Construction and operation of desalination facilities would have a very low potential to result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally designated mineral resource recovery site. This is because the desalination facilities would likely be within existing WWTPs. If the desalination facilities are located within a state or locally designated mineral resource area, construction and operation of the desalination facilities would not permanently remove access to a mineral resource because there would be other locations around the facilities that could provide access to the mineral resource. Impacts would be less than significant.

Potential Environmental Effects of Wastewater Treatment Plant Desalination

Resource	Discussion
Noise	• Construction would potentially take place in Mountain House (San Joaquin County), and the Cities of Tracy and Stockton, since desalination facilities would likely be within or adjacent to existing WWTPs. Each of these jurisdictions have noise requirements in their general plans or zoning ordinances for construction and operation based on land use designations and timing restrictions. Noise requirements are typically based on land uses that are considered more sensitive to ambient noise levels than others due to noise exposure. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and outdoor recreation or natural areas are typically more sensitive to noise than are commercial or industrial land uses. Therefore, local noise standards are typically more stringent for sensitive land uses in terms of level of noise generated, duration, and frequency than less sensitive uses. Given the wide ranges of land uses throughout San Joaquin County, noise levels can range from louder high density residential and industrial uses or roadway uses to more quiet open space and agricultural areas (San Joaquin County 1992). Frequently, the most common and loud noise generating activity in San Joaquin County affecting the overall permanent ambient noise setting is freeway traffic on I-5, I-205, and SR-4 and along railroads and in heavy industrial areas (e.g., Port of Stockton) or around airports (San Joaquin County 1992). • The City of Tracy and the City of Stockton regulate generation of construction noise by restricting the timing that construction can occur (e.g., operating construction requirement from 10pm to 7pm is prohibited) and the land use or adjacent land uses under which the noise generating activity occurs (City of Stockton n.d., City of Tracy n.d.). San Joaquin County exempts noise sources associated with construction, provided they do not take place before 6am or after 9pm (San Joaquin County n.d.). Construction of desalination facilities could generate temporary noise and as such could expose people to noise levels in excess of standards. It is likely desalination facilities would be constructed in areas with suitable land use designations and zoning for infrastructure (e.g., public facilities or industrial) and would be unlikely to have sensitive receptors (e.g., homes, hospitals, schools) within close proximity. If sensitive receptors were adjacent to construction activities and experienced a temporary increase in ambient noise levels due to construction, and the noise generating activities would be required to follow existing local noise ordinances limiting the timing of construction. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant noise impacts related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, depending on the potential location of possible sensitive receptors and the duration of the particular noise generating activities over the course of construction. • Construction activities that typical result in ground-borne vibrations or ground-borne noise are activities such as pile driving, where the ground is repeatedly struck and vibrations or noise can be generated. Pile driving may be needed to construct desalination facilities. Some local agencies (e.g., San Joaquin County) exempt vibrations associated with construction provided it is occurring within certain hours (San Joaquin County n.d). However, if pile driving is used, and there are sensitive receptors to noise (e.g., homes, hospitals, schools) within close proximity, Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant noise impacts related to construction.

Potential Environmental Effects of Wastewater Treatment Plant Desalination	
Resource	Discussion
	Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • Desalination facilities would generate constant noise during operation. Existing WWTPs already generate intermittent noise (e.g., from alarm bells, pumps, and generators). It is anticipated there would be a low probability that sensitive receptors (e.g., homes, hospitals, schools) would be located within close proximity to experience the operating noise generated because it is anticipated that the WWTPs would be located in areas with similar land uses (e.g., other public facilities or CII facilities). Additionally, most of the wastewater treatment facilities are enclosed within buildings or behind walls that can reduce the operating noise. As such, a permanent increase in ambient noise under operating conditions is not expected. Impacts would be less than significant. • Assuming construction and operation of desalination facilities would be located in San Joaquin County, there are six public access airports within the county (SJCOG n.d.[a]). The Stockton Metropolitan Airport, San Joaquin County Airport have approved Airport Land Use Compatibility Plans, which identifies noise contours and where noise exposures may take place as a result of aircraft flight patterns consistent with Federal Aviation Administration requirements (SJCOG n.d.[a]). Other airports, such as the City of Tracy, have either airport master plans or other planning documents that outline noise contours consistent with FAA requirements (City of Tracy 1998). While it is unknown where construction or operation of salinity source controls might occur, the construction and operation of desalination facilities would not bring new or additional people within close proximity to an airport or private airstrip or expose people to noise generated by air traffic on a regular basis. This is because desalination facilities are expected to be automated and would not result in an increased permanent work force cited within proximity to an airport or private airstrip. Nor would desalination facilities result in a population increase that would be exposed to airport noise. Impacts would not occur.
Population and Housing	• The construction and operation of desalination facilities would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property or population growth in an area. Further, it would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people to the southern Delta. Finally, they would not be constructed and operated increase capacity to serve new users. Impacts would not occur. • The construction and operation of desalination facilities would not displace substantial numbers of people or housing, or necessitate the construction of replacement housing elsewhere because the facilities would be located in the existing footprint of WWTPs or closely adjacent in industrial or public land use type areas. As such, it is not expected people would reside in these areas. Impacts would not occur.
Public Services	• The need for additional public services (e.g., fire protection, police protection, parks, libraries, schools) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, the construction and operation of desalination facilities would not involve an increase in population or housing. In addition, these actions do not include proposals for new housing, and would not generate students or increase demands for school services or facilities. Impacts would not occur.

Potential Environmental Effects of Wastewater Treatment Plant Desalination

Resource	Discussion
Recreation	• Construction of desalination facilities would likely occur within the footprint or immediately adjacent to existing wastewater treatment facilities. These facilities are typically located adjacent to receiving waters and in CII or urban areas to provide wastewater service to urban, suburban, and CII users of the wastewater system. So it is unlikely recreational facilities would be located in areas where wastewater treatment facilities currently exist. However, if recreational facilities were located within very close proximity, recreational facilities could be affected by noise levels or other temporary construction activities. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to construction. • An increase in use of existing recreational facilities is typically associated with a substantial increase in the population to accommodate new recreationists. Construction or operation of desalination facilities would not result in a substantial increase in population because it would not result in the development of housing or other population-inducing development (e.g., job centers). The purpose of the construction and operation of desalination facilities would be to comply with water quality objectives. Construction and operation of these facilities would satisfy existing demand, not meet new projected demand for wastewater treatment or water supply (Section 16.4.1, *New Source Water Supplies*). Impacts would be less than significant. • Construction and operation of desalination facilities would not include recreational facilities or require the construction or expansion of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Assuming construction and operation of desalination facilities would occur in San Joaquin County, because that is where the cities of Tracy and Stockton are located, as well as Mountain House CSD, the project(s) would be subject to the SJCOG Regional Congestion Management Program (SJCOG 2016b). As described in the Regional Congestion Management Program, projects are subject to a tiered review process, unless exempt from CEQA or unless considered as part of a previously approved project (SJCOG 2016b). Projects that trigger 125 or more vehicle trips during weekday AM or PM peak-hours or 500 or more total vehicle daily trips on any day of the week would be required to perform a quantitative regional traffic analysis. The Regional Congestion Management Program provides for mitigation to reduce effects if trips occur at those levels and these are included in Table 16-38. Trips that are exempted from the RCMP standards, and are removed from calculations of LOS standards under the RCMP include trips resulting from construction (SJCOG 2013). A total of 103 intersections have been designated as part of SJCOG Regional Congestion Management Program (SJCOG n.d.[b]). Designation of RCMP intersections allows for congestion monitoring and appropriately focuses attention at locations where operational constraints are typically experienced on arterial roadways (SJCOG n.d.[b]). Of approximately 1,500 congestion management roadway segment miles, 245 operate at a LOS D, with approximately half of these in the county, and the remaining in the cities of Stockton, Lathrop, and Manteca and Tracy (Table 4 in Dowling Associates 2010). There are approximately 92 miles of CMP lanes operating at LOS E or F, with more than half located in county areas, and 16 percent in Stockton (Table 4 in Dowling Associates 2010). Operation of desalination facilities would generate additional truck trips to dispose of the waste brine generated by the desalination process. The number of truck trips depends on the volume and salt concentration of the wastewater treated; therefore, the number of trucks that would be required is

Potential Environmental Effects of Wastewater Treatment Plant Desalination	
Resource	Discussion
	unknown, as is the roads they would travel or their ultimate destination (i.e., landfill or other facility). Trucks would likely not be required every day because the evaporation ponds would first dewater the brine solution. As discussed above, if a project exceeds the criteria established by the Regional Congestion Management Program on roads identified in that program (e.g., 125 or more vehicle trips during weekday AM or PM peak-hours or 500 or more total vehicle daily trips on any day of the week), mitigation would be applied through that program. The criteria is particularly high and is generally applicable to development such as office parks, retail, or housing developments that would generate substantial numbers of trips. However, Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant transportation and traffic impacts related to operations, if indeed disposal resulted in exceedances of the Regional Congestion Management criteria. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented and consistency with the Regional Congestion Management Plan was determined. • Construction and operation of desalination facilities could result in some additional trips. It is unknown the number of construction and operational trips that might be needed and the location of these tips, but it is anticipated that construction would be relatively limited in duration. Typically, construction activities are exempt from local road trip thresholds because construction is temporary. However, depending on the quantity of trips and the duration, the temporary increased traffic during construction or the increase in operational trips associated with brine disposal could exceed local or regional road trip thresholds (either vehicle miles traveled or level of service, as discussed in Table 16-25, changes to the methodology and criteria for evaluations are occurring). Projects would be required to evaluate trip generating activities through the respect jurisdiction traffic impact analysis guidelines depending on the location and number of trips generated (City of Stockton n.d.). Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts on transportation and traffic related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction. • Construction of desalination facilities is not expected to result in hazards to, or on, roadways because they would primarily be constructed within existing footprints of facilities or in close proximity. Similarly, construction activities are not expected to conflict with public transit facilities, public bicycle facilities, or pedestrian facilities (e.g., sidewalks). The development of project-specific construction traffic management plans, as identified in Table 16-38 would reduce potentially significant impacts if hazards on the roadway were temporarily created during construction due to construction related activities. Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts of transportation and traffic related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable,

Potential Environmental Effects of Wastewater Treatment Plant Desalination

Resource	Discussion
	consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant, given the low likelihood of occurrence and because construction impacts would be temporary. • Similar to the discussion in Hazards and Hazardous Materials, it is not expected that construction of desalination facilities would result in inadequate emergency access, given the location of the construction work would primarily within the existing footprint of existing WWTPs or in close proximity to them. Similarly, construction activities are not expected to conflict with public transit facilities, public bicycle facilities, or pedestrian facilities (e.g., sidewalks) because they would be constructed within existing footprints of facilities. As such, there is a low likelihood of interfering with emergency access, public transit facilities, public bicycle facilities, or pedestrian facilities. However, Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts of transportation and traffic related to construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. It is likely that impacts could be mitigated to less than significant, given the low likelihood of occurrence and because construction impacts would be temporary. • Construction and operation of desalination facilities would not result in an increase demand for air traffic or the need for airports because this type of project would not result in an increase in population and is not related to air traffic or airports. Impacts would not occur. • Operation of desalination facilities is not expected to result in a permanent substantial increase in hazards due to a design feature or incompatible use, permanent inadequacy of emergency access, or a permanent change that would decrease the performance or safety of public transit facilities, public biking facilities, or public pedestrian facilities because it is anticipated that these would be located within existing facility footprints or within close proximity. Trips associated with brine disposal would be done on existing roads and as such, would not result in permanent substantial hazards or conflicts with emergency access and public transit, bicycle, or pedestrian facilities. Impacts would be less than significant.

Potential Environmental Effects of Wastewater Treatment Plant Desalination

Resource	Discussion
Utilities and Service Systems	• The construction and operation of desalination facilities would not be expected to exceed wastewater treatment requirements of the Central Valley Water Board because, by removing salts, it would actually improve the treated effluent quality. Additionally, it would not result in a determination by the wastewater treatment provider that it has inadequate capacity to meet the service area's demand because the desalination facilities would not increase the actual volume of wastewater generated in the service area. Impacts would be less than significant. • The construction and operation of desalination facilities involve construction at wastewater treatment facilities. Environmental effects associated with implementation of desalination facilities are discussed throughout this table (Aesthetics through Transportation and Traffic). Table 16-38 lists potential mitigation measures that lead agencies (e.g., wastewater treatment special districts or municipalities) can and should implement to reduce potentially significant impacts related to construction and operation of desalination facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • The construction and operation of desalination facilities would involve processing treated wastewater to remove additional salts before discharge into receiving waters. It is not anticipated that the demand for water would increase because desalination would be treating wastewater already generated by the service area. Further, it is not expected that this process would require new entitlements for water because it is at the end of the wastewater treatment process. As such, impacts would be less than significant. • The construction and operation of desalination facilities would not need the construction of additional storm water drains because desalination facilities would likely be built within the footprints of existing wastewater treatment facilities, which currently have impervious surfaces that generate runoff; therefore, it is expected that existing storm water infrastructure would be used. Impacts would be less than significant. • The construction and operation of desalination facilities could generate solid waste in the form of brine. This type of solid waste is not considered hazardous, and the disposal of brine would follow all regulations and guidelines of solid waste in Class I/II landfills (non-hazardous waste landfills). Impacts would be less than significant.

16.4.4 Agricultural Return Flow Salinity Control

Real-time management of agricultural return flow, such as changing the timing of the release of agricultural discharge to receiving waters, is a reasonably foreseeable method of compliance for agricultural water users that must comply with numeric salinity objectives. This method may reduce salinity entering the southern Delta.

Cost Evaluation

Agricultural dischargers could monitor receiving water's assimilative capacity on a real-time basis, and time discharges to coincide with periods of high flow (i.e., more assimilative capacity). This potential method of compliance with proposed salinity standards would require dischargers to establish a network of monitoring stations and a discharge schedule. When there is no assimilative capacity, irrigators would either recycle water that would otherwise be discharged or would discharge to a detention pond until discharges to the receiving waters are permitted. This method of compliance could be integrated with other BMPs, such as water recycling, to reduce salinity entering the plan area.

Temporary discharge basin sizing was estimated in the Central Valley Water Board's *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Salt and Boron Discharges into the Lower San Joaquin River, July 2004* (Basin Plan Amendments 2004). The Basin Plan Amendments analyzed a project area that included 1.4 million acres of irrigated agricultural land. The Central Valley Water Board estimated that for this irrigated area, 50,000 AF of water may need to be stored annually when there is no assimilative capacity in the river (Central Valley Water Board 2004). For this plan area, it is assumed that there are roughly 137,000 acres of irrigated agricultural land (roughly the size of the South Delta Water Agency [SDWA]). Using the relationship of detention volume to agricultural land developed in the Basin Plan Amendments 2004 and this plan area's assumed irrigated land acreage, it is estimated that this method of compliance would need 4.9 TAF of detention basin storage. If each detention basin is 10 ft deep, approximately 490 acres could be used for this potential method of compliance.

Enhanced monitoring equipment, modeling, and forecasting capability would be needed to forecast assimilative capacity in the LSJR. Control gates and conveyance systems would also be needed to divert drainage from river discharge to permanent treatment structures when assimilative capacity is not available. Personnel would be needed to manage real-time systems and coordinate discharges from multiple subareas in the LSJR Watershed (Central Valley Water Board 2004). It is assumed that there would be multiple subareas within the plan area that would manage discharges in real time, creating a real-time monitoring system. Table 16-31, *Costs and Components of a Real-Time Management System*, estimates the components needed and costs associated with constructing a real-time management system.

Table 16-31. Costs and Components of a Real-Time Management System

Construction	Cost
Computer and Software	$ 5,000
Control Gates (10)	$ 100,000
Floats, Weirs, and EC Monitoring Equipment	$ 50,000
Installation of Monitoring Components	$ 75,000
Conveyance to River	$ 100,000
Subtotal	$ 330,000
Contingency (30%)	$ 99,000
Total Construction Cost	$ 429,000
Operations and Maintenance	
Operations and Maintenance (Including Coordinating Discharges)	$100,000 per year

Source: Central Valley Water Board 2004.
EC = electrical conductivity (salinity).
EC is electrical conductivity, which is generally expressed in deciSiemens per meter (dS/m) in this document. Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million).

The costs in Table 16-31, *Costs and Components of a Real-Time Management System,* were adapted from the Central Valley Water Board's Basin Plan Amendments 2004. Costs for a real-time management system in the plan area were assumed to be the same as those in Table 16-31, but the contingency was increased to 30 percent of construction costs based on best professional judgment. It is assumed that 11 systems would need to be constructed to effectively cover the major water users in the plan area (Central Valley Water Board 2004). The total estimated construction cost for 11 systems is $4,719,000, with an operations and maintenance budget of $1,100,000 per year.

Environmental Evaluation

Summary of Potential Action

Real-time management is a reasonable foreseeable salinity control measure that would include shifting the agricultural discharge timing to allow agricultural return flows released from agricultural lands to occur during times of high assimilative capacity for the receiving waters. This would require agricultural dischargers to hold or contain their discharge in detention ponds and release it at different times of the year. The agricultural dischargers could hold salt in the soil column for a period of time and then leach it by applying water. The leached water (e.g., agricultural return flow) could be held in a detention pond or released directly into the receiving water, depending on the assimilative capacity of the receiving water at the time of leaching. While assimilative capacity can increase in receiving waters during higher flows, the relationship between assimilative capacity and flow is not always linear. The construction of detention ponds on the agricultural discharger property would likely be contained in close proximity to the discharge point and the generation source (e.g., fields and orchards in the southern Delta). The location, timing of construction, and details of operation for the detention ponds are unknown. However, detention ponds for these types of purposes would likely be less than 0.5 acre and take a few months to construct. The volume of agricultural discharge would essentially remain the same, and discharges would be expected to occur from current outfall locations along the receiving waters.

Potential Environmental Effects

The most likely potential effect of a change in discharge timing and the use of detention ponds would be the repurposing of lands currently used for agriculture. Discharge timing or the use of detention ponds would not result in the loss of agricultural land (Prime Farmland, Unique Farmland, or Farmland of Statewide Importance) but only a reuse of that land. While there may be economic effects for individuals, the amount of land temporarily taken out of production would be small compared to the amount of agricultural land in the southern Delta (primarily located in San Joaquin County). There is some potential that natural and cultural resources (significant historical, archaeological, or paleontological resources) adjacent to existing agricultural lands could be affected. However, construction and operation of detention pond facilities on farmland would be subject to county code and potential county permit requirements (e.g., agricultural excavation permit), which could minimize potential construction- and operation-related effects on natural and cultural resources. San Joaquin County, as part of the county permitting process for agricultural excavation, determines if a proposed project would result adverse environmental effects. If the County determines that there is no potential for adverse effect(s) from a proposed project, a permit is issued. However, if it is determined that there is potential for a project to result in adverse effects, the County would require environmental review under CEQA to issue the permit.

CEQA allows categorical exemptions for classes of projects which have been determined not to have a significant effect on the environment. (Pub. Res. Code, § 21084.) Specifically, modification or demolition of existing facilities can be exempt from CEQA under a Class 1 categorical exemption. The Class 1 categorical exemption consists of the minor alteration of existing public or private structures, facilities, topographical features, involving negligible or no expansion of use beyond that existing at the time of the lead agency's determination. The types of "existing facilities" listed in the exemption are not intended to be all-inclusive of the types of projects which might fall within the CEQA exemption. The key to the consideration of this class of categorical exemptions is whether the project involves negligible or no expansion of an existing use. As construction and operation of detention ponds on agricultural land would not expand an existing use, the detention ponds may be eligible for a Class 1 categorical exemption depending on the project-specific circumstances. Table 16-32, *Potential Environmental Effects of Agricultural Return Flow Salinity Controls*, summarizes the potential environmental effects associated with agricultural return flow salinity controls. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, at the end of this chapter lists potential mitigation measures associated with the construction or operation of the methods of compliance and is referenced in Table 16-32 where appropriate.

Table 16-32. Potential Environmental Effects of Agricultural Return Flow Salinity Controls

Potential Environmental Effects of Agricultural Return Flow Salinity Controls	
Resource	Discussion
Aesthetics	• The detention ponds that may store agricultural discharge would be on private agricultural property in the southern Delta. There are relatively few sensitive receptors to views in the southern Delta, but receptors may include boaters on southern Delta waterways. Because the detention ponds would be relatively small and below grade, are not expected to involve large buildings or facilities, and would not likely require permanent lighting, the potential to substantially adversely affect a scenic vista or substantially degrade the existing visual character or quality of the sites where they are to be installed would be low. The detention ponds may be fenced for security purposes, and this fencing would serve as a screen from viewers. The detention ponds would not substantially detract from the existing view of agricultural activities and facilities in the southern Delta. Further, detention ponds would not substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic building within view of the two state-designated scenic highways in San Joaquin County, I-5 and I-580, because the ponds would be installed and operated on existing actively farmed land where these resources are not likely to occur or can be easily avoided. Impacts would be less than significant.
Agriculture and Forestry Resources	• The detention ponds would likely be constructed and operated within existing agricultural land (including Prime Farmland, Unique Farmland, or Farmland of Statewide Importance). They would be relatively small in size when compared to the overall amount of agricultural land in production in the southern Delta. Therefore, they would have a low potential to convert large amounts of agricultural land. Furthermore, using agricultural land for agricultural ponds would be considered an agricultural use and would be supporting existing agricultural lands by reducing salinity of the discharge used for irrigation and improving the water quality of the southern Delta. Because of this, detention ponds would likely be included within agricultural land use designations and zoning. If the construction and operation of detention ponds were inconsistent with local land use plans, policies and regulations, and required a discretionary action by a local government agency, the project would obtain an amendment or variant from the local jurisdiction prior to operation. The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects on agricultural resources. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the small area of disturbance and the purpose of detention ponds to support agricultural uses. • Construction and operation of the detention ponds would not be located on forest land or timberland because they would likely be constructed and operated within existing agricultural lands. Impacts would not occur.

Potential Environmental Effects of Agricultural Return Flow Salinity Controls	
Resource	Discussion
Air Quality	• Construction of detention ponds would likely result in emissions associated with construction equipment and construction vehicles, as well as fugitive dust emissions from ground disturbance. The quantity, duration, and the intensity of construction activity have an effect on the amount of construction emissions and related pollutant concentrations occurring at any one time. As such, more emissions are typically generated by relatively large amounts of relatively intensive construction. SJVAPCD's published guidelines, *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002) do not require the quantification of construction emissions. Rather, the guidelines require implementation of effective and comprehensive feasible control measures to reduce PM10 emissions (SJVAPCD 2002). SJVAPCD considers PM10 emissions to be the greatest pollutant of concern when assessing construction-related air quality impacts and has determined that compliance with its Regulation VIII, including implementation of all feasible control measures specified in its *Guide for Assessing Air Quality Impacts* (SJVAPCD 2002), constitutes sufficient mitigation to reduce construction-related PM10 emissions to less-than-significant levels and minimize adverse air quality effects. All construction projects must abide by Regulation VIII. Since the publication of SJVAPCD's guidance manual, the district has revised some of the rules comprising Regulation VIII. Guidance from SJVAPCD staff indicates that implementation of a Dust Control Plan would satisfy all of the requirements of SJVAPCD Regulation VIII (Siong pers. comm.). However, if construction is conducted over a longer time period, emissions could be "diluted" relative to construction that would occur over a shorter time period because of a less intensive buildout schedule (i.e., total daily or yearly emissions would be averaged over a longer time interval). Since construction of detention ponds does not require lengthy construction activities, the potential for significant environmental effects is minimal. Further, construction emissions generated would need to comply with the SJVAPCD regulations and established thresholds. Impacts would be less than significant. • Operation of detention ponds would not release air quality emissions because changing the timing of the release of discharge into receiving waters would not generate air quality emissions. As such, operations would not have the potential to emit criteria pollutants, result in a net increase of criteria pollutants, conflict with an applicable air quality plan, or contribute to objectionable odors. Impacts would not occur. • SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJVAB. Some of these facilities are wastewater treatment facilities, sanitary landfills, transfer stations, composting facilities, petroleum refineries, asphalt batch plants, chemical manufacturing facilities, fiberglass manufacturing facilities, painting/coating operations, food processing facilities, feed lots/dairies, and rendering plants (SJVAPCD 2002). Construction and operation of detention ponds would not involve the type of facility identified by, for example, SJVAPCD, as a known odor source. Consequently, it is not expected detention ponds would create objectionable odors affecting a substantial number of people. Impacts would be less than significant.

Potential Environmental Effects of Agricultural Return Flow Salinity Controls

Resource	Discussion
Biological Resources	• Construction of detention ponds would result in soil disturbance and alteration of drainage in areas of active agricultural management. There is generally a low potential for candidate, sensitive, or special-status species, or habitat (including federally protected wetlands, riparian habitat, or other sensitive natural communities) in these areas because of ongoing farming activities and the changing landscape. Similarly, because detention ponds would be located on existing, actively farmed agricultural land, it is unlikely that construction of detention ponds would substantially interfere with the movement of any native resident or migratory fish or wildlife species or associated migratory corridors, or impede the use of native wildlife nursery sites. The lead agency with permitting approval over the ponds can and should implement the mitigation measures listed in Table 16-38 to reduce potentially significant environmental effects on biological resources, if it is determined that sensitive species or habitat is present. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because of the small area of disturbance and the low likelihood of special status species to exist. • Because detention ponds would be located on existing, actively farmed agricultural land, it is unlikely that construction and operation of the ponds would conflict with local policies and ordinances protecting biological resources, or conflict with an adopted natural community conservation plan or habitat conservation plan. Construction and operation of detention ponds would occur within the SJMSCP Plan Area; however, agricultural activities located on agriculturally zoned land are not covered (SJCOG 2016a). As discussed above, the lead agency with permitting approval over the ponds can and should implement the mitigation measures listed in Table 16-38 to reduce potentially significant environmental effects on biological resources, if it is determined that sensitive species or habitat is present. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because of the small area of disturbance and the low likelihood of special status species to exist. • Operation of detention ponds would be expected to discharge agricultural flow into receiving waters when salinity levels in the river are below the designated salinity objective and with high assimilative capacity (i.e., ability for the receiving waters to increase salt concentration without exceeding salinity objectives). Salinity concentration in the receiving waters would not result in significant impacts on fish and wildlife. Additionally, these fish and wildlife are adapted to tidally influenced environments which exhibit a wide range of salinity levels. Impacts would be less than significant.
Cultural Resources	• Construction of detention ponds would result in ground disturbance in existing managed and active agricultural lands in the southern Delta. It is likely managed and active agricultural lands have been disturbed before; however, cultural resources (significant historical, archeological, or paleontological resources) could exist depending on the location of disturbance and depth of disturbance. The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant environmental effects associated with construction of detention ponds should unknown significant cultural resources be discovered during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that

Potential Environmental Effects of Agricultural Return Flow Salinity Controls

Resource	Discussion
	impacts could be mitigated to less than significant once mitigation measures were implemented because of the small area of disturbance and the low likelihood of cultural resources to exist. • Construction of detention ponds would result in ground-disturbing activities at depths greater than 6 ft. It is considered highly unlikely human remains, typically buried at depths of 6 ft, would be disturbed during construction, because these lands have been in agricultural production and have been regularly disturbed. In the event human remains are uncovered during construction, compliance with the State Health and Safety Code would be required. As specified by Section 7050.5 of the Health and Safety Code, and described in Table 16-38, no further disturbance shall occur until the county coroner has made the necessary findings as to origin and disposition pursuant to Public Resources Code Section 5097.98. If such a discovery occurs, excavation or construction shall halt in the area of the discovery, the area shall be protected, and consultation and treatment shall occur as prescribed by law. If the coroner recognizes the remains to be Native American, he or she shall contact the NAHC, who shall appoint the Most Likely Descendent. Additionally, if the human remains are determined to be Native American, a plan shall be developed regarding the treatment of human remains and associated burial objects, and the plan shall be implemented under the direction of the Most Likely Descendent. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because of the small area of disturbance and the low likelihood of human remains to exist. • Operation of detention ponds would result in a change in timing of release of water or a change in the volume of agricultural return flow released and would not involve ground-disturbing activities. Therefore, it is highly unlikely any known or unknown cultural resources would be affected because of the lack of ground-disturbing activities during operation. Impacts would be less than significant.
Geology and Soils	• The new detention ponds could occur in areas known to have an earthquake fault, experience strong seismic ground shaking, experience seismic-related ground failure, experience landslides, or be located on a geologic unit or soil that is unstable or be located on expansive soil. However, construction and operation of a detention pond would not result in an impact on, or be affected by: Alquist-Priolo faults, strong seismic shaking, seismic-related ground failure, unstable geologic units, expansive soils or landslides. Furthermore, storing agricultural return flow in a detention pond would not bring people to the risk of earthquakes or geologic hazards, meaning construction or operation of detention ponds would not substantially increase the number of people exposed to the risk of earthquakes or geologic hazards because it would not draw people to earthquake areas or hazard locations not already frequented. Impacts would not occur. • Construction of detention ponds would result in ground-disturbing activities that could result in soil erosion or loss of topsoil; however, ground-disturbing activities would be limited in duration and geography. The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant impacts related to soil erosion and storm water runoff. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented because of the small area of disturbance and the limited duration of disturbance.

Potential Environmental Effects of Agricultural Return Flow Salinity Controls	
Resource	Discussion
	• Operation of detention ponds would involve the release of agricultural return flow into receiving waters. It is expected the releases would occur at existing discharge points and the releases would not result in erosion or topsoil loss. Impacts would be less than significant. • Construction and operation of detention ponds would not involve constructing or operating septic tanks and, therefore, they would not be affected. Impacts would not occur.
Greenhouse Gas Emissions	• Similar to the discussion in Table 16-7, construction of detention ponds would likely result in increased use of electricity and fuels and, therefore, an increase in GHG emissions that could exceed SJVAPCD's ZEL and result in a potentially significant impact. The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant impacts related to construction and operation activities and GHG emissions. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • In September 2006, the California State Legislature adopted AB 32. AB 32 establishes a cap on statewide GHG emissions and sets forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, the ARB is required to take the following actions. ○ Adopt early action measures to reduce GHGs. ○ Establish a statewide GHG emissions cap for 2020 based on 1990 emissions. ○ Adopt mandatory report rules for significant GHG sources. ○ Adopt a scoping plan indicating how emission reductions would be achieved through regulations, market mechanisms, and other actions. ○ Adopt regulations needed to achieve the maximum technologically feasible and cost-effective reductions in GHGs AB 32 establishes a statewide GHG reduction target from which most local GHG thresholds are based and substantial evidence is taken for these established GHG thresholds. Therefore, if GHG emissions are in excess of a relevant threshold, then it would conflict with the reduction targets established by AB 32 and would be inconsistent with the AB 32 Scoping Plan. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts from GHG emissions associated with construction and operation of the facilities. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. • The release of agricultural return flow into receiving waters from detention ponds does not have the potential to emit GHGs. Impacts would not occur.

Potential Environmental Effects of Agricultural Return Flow Salinity Controls

Resource	Discussion
Hazards and Hazardous Materials	• Construction of detention ponds would be short term and may involve the limited transport, storage, use, and disposal of hazardous materials such as fuel and lubricating grease for motorized heavy equipment. Some examples of typical hazardous materials handling are fueling and servicing construction equipment on the site, and transporting fuels, lubricating fluids, solvents, and bonding adhesives. These types of materials are not acutely hazardous, and storage, handling, and disposal of these materials are regulated by local, county, and state laws. Furthermore, the quantities of these materials used during construction would be small (e.g., less than 100 gallons) because construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained. The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant impacts associated with hazardous materials during construction of detention ponds. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented, given the temporary nature of construction, the short duration of construction, and the relatively small quantities of hazards handled. • There are eight sites within San Joaquin County that are identified on the Hazardous Waste and Substance Site List (Cortese Site list) as sites being hazardous materials sites under Government Code Section 65962 (CalEPA 2016). Construction and operation of detention ponds are not likely to be located on these eight sites or interfere with these sites because the construction and operation of detention ponds would be in agricultural areas and would not involve activities at the sites on this list (e.g., Lawrence Livermore National Lab, McCormick and Baxter Creosoting Company). CalEPA identifies leaking underground storage tank sites, sites that have received CDOs or CAOs, and hazardous waste facility sites where DTSC has taken corrective Action (CalEPA 2016). There are no hazardous waste facility sites where DTSC has taken corrective action in San Joaquin County (CalEPA 2016). As such, construction of detention ponds would not affect them. There are approximately 244 leaking underground storage cases in San Joaquin County designated as open (CalEPA 2016). Sixteen facilities in San Joaquin County have received CDOs or CAOs and have active cases, but may not be necessarily related to hazardous waste (CalEPA 2016). The location of construction of detention ponds is unknown, but could occur on one of these sites as some of the sites are agriculturally related land uses. During excavation or soil disturbance potentially contaminated soil could be encountered. As such, the lead agency with permitting approval over the ponds can and should implement potential mitigation measures in Table 16-38 to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed. • Assuming construction of detention ponds would be located in San Joaquin County, there are six public access airports within the county (SJCOG n.d.[a]). While it is unknown where construction of detention ponds might occur, they would occur within agricultural areas. Furthermore, they would not result in the construction of structures that would result in a safety conflict with airport land use plans. As such, impacts would be less than significant. San Joaquin County has 14 school districts and more than 200 schools (San Joaquin County Office of Education n.d.). The location of

Potential Environmental Effects of Agricultural Return Flow Salinity Controls

Resource	Discussion
	construction of detention ponds unknown. They are likely to occur in primarily agricultural lands and the likelihood of a school being within one-quarter mile (0.25 miles) is low. However, hazardous materials may be used during construction (e.g., fuels, lubricants, diesel). While it is expected materials would be handled, used, and stored properly in accordance with local, state and federal regulation, and contained in the event of an accidental release, if an accidental release occurred, it could occur within proximity to a school. Additionally, depending on the location of construction, remediation may be needed to address soil contamination during excavation activities. As such, if a school existed within close proximity to a construction site, those mitigation measures identified table 16-38 applied to project-specific construction needs would reduce potentially significant impacts during construction. The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 to reduce potentially significant impacts associated with hazardous materials during construction. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once implemented because hazardous materials contamination could be remediated and removed and because the measures would ensure the appropriate handling of hazardous materials during construction. • Construction and operation of detention ponds would not physically interfere with an adopted emergency response plans or emergency evacuation plans since they would be located on existing agricultural lands and therefore would not prohibit the mobility of people to escape potential emergencies. Furthermore, construction and operation does not involve an increase in population that would necessitate reconsideration of how to evacuate people in an emergency. Impacts would not occur. • Operation of detention ponds would result in a change in timing or volume of agricultural return flow discharged into receiving waters. The activity of discharging agricultural return flow would not result in the use, transport, or disposal of hazardous materials, nor would it interfere with an airport or result in an increased risk of wildland fire exposure. Impacts would not occur.
Hydrology and Water Quality	• Construction of detention ponds would entail ground-disturbing activities, such as grading, that could result in temporary changes to existing drainages (including any storm water drainage), erosion, or runoff. However, ground-disturbing activities would be limited in duration and geography (i.e., detention ponds would generally be constructed on approximately 0.5 acre of land or less). Further, it is assumed that as part of adhering to city and/or county grading/excavation permits or other applicable permit requirements, detention pond construction would be such that changes to drainage and erosion or runoff are minimized, and existing drainage patterns would not be substantially altered such that onsite flooding would occur. In addition, as discussed in this table for Hazards and Hazardous Materials, construction of detention ponds may involve the limited transport, storage, use, and disposal of hazardous materials, which, if spilled, could have adverse effects on water quality depending on the location and magnitude of the spill. However, storage, handling, and disposal of these materials is regulated by local, county, and state laws, and the quantities of these materials used during construction would be small (e.g., less than 100 gallons) and construction would be limited in duration. Therefore, if a spill occurred, it could be readily and easily contained and, as such, violations of water quality standards are not expected to occur. The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 to reduce

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Resource	Discussion
	potentially significant impacts on hydrology and water quality. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction, the short duration of construction, and the relatively small area of ground disturbance. • Operation of a detention pond is expected to change the seasonal fluctuations of agricultural return flow by changing the timing of the discharge from agricultural lands to receiving waters. Although the discharge could have a different salinity concentration than the discharge previously released, the change in timing of the release would allow the receiving water to have higher assimilative capacity. Thus the discharge would not be considered polluted runoff. The same volume of discharge would be released under baseline conditions when compared to being released from detention ponds. It is likely that the discharges would occur during higher flows or normal flows when there may be more assimilative capacity. Water quality standards would be maintained because the discharge would have to comply with the Central Valley Water Board's water quality requirements. Impacts would be less than significant. • Detention ponds could be located within a 100-year flood hazard area; however, these structures are of low relief, and/or below ground surface, and would not impede or redirect flood flows. Additionally, the detention ponds would not substantially increase the number of people exposed to the risk of flooding because they would not draw people to flood hazard locations or result in the construction of housing in a 100-year flood hazard area. Accordingly, detention ponds would not expose people to significant loss, injury, or death related to flooding. Impacts would be less than significant. • Detention ponds would be constructed in areas of low land relief. Therefore, these locations would not support mudflows, which typically need very steep slopes and large amounts of precipitation to occur. Furthermore, these areas would not be adjacent to the ocean and would not be affected by tsunamis. Impacts would be less than significant. • A seiche is an oscillation of the surface of a landlocked body of water that varies in period from a few minutes to several hours that is caused by ground movement generated by meteorological effects (e.g., wind) or earthquakes. Construction and operation of detention ponds are not expected to occur near a lake or reservoir. Impacts would not occur. • Construction and operation of the detention ponds would not substantially deplete groundwater supplies because groundwater would not be pumped. In addition, construction and operation of the detention ponds would not interfere with groundwater recharge because no impervious surfaces would be constructed. Impacts would not occur. • There are no other ways in which construction or operation of detention ponds could result in a substantial degradation to water quality.

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Resource	Discussion
Land Use and Planning	• Construction and operation of detention ponds is not expected to physically divide an established community because the ponds would be developed on existing agricultural land, support existing agricultural practices, and because the discharge locations already exist on the agricultural lands. Detention ponds would be considered agricultural infrastructure and likely included within agricultural land use designations and zoning. If the construction and operation of detention ponds were inconsistent with local land use plans, policies and regulations, and required a discretionary action by a local government agency, the project would obtain an amendment or variant from the local jurisdiction prior to operation. Impacts would be less than significant. • Construction and operation of detention ponds would likely take place in the Delta and may be considered covered activities under the Delta Plan. Only the lead CEQA state or local agency may determine whether that plan, program, or project is a covered action of the Delta Plan. If an action is covered, consistency with the Delta Plan would be determined. The consistency determination would include implementing mitigation from the Mitigation Monitoring or Reporting Program of the Delta Plan, as appropriate. Table 16-38 lists potential mitigation measures that lead agencies (e.g., municipalities or municipal water purveyors) can and should implement to reduce potentially significant impacts related to consistency with the Delta Plan. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely impacts could be reduced once mitigation was implemented because once a lead agency determines an action is covered and complies with the Mitigation Monitoring or Reporting Program, consistency would be determined and impacts would be less than significant. • Potential conflicts with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations protecting biological species and resources are evaluated in the Biological Resources section of this table.
Mineral Resources	• The California SMARA requires the State Geologist to classify land into MZs, according to the known or inferred mineral potential of existing land. The primary goal of mineral land classification is to ensure that the mineral potential of land is recognized by local government decision-makers and considered before land-use decisions are made that could preclude mining. Local general plans, specific plans, and other local plans refer to, and use the information produced by the State Geologist, to identify mineral resources because they are specialized evaluations and because the California geologic survey is the designated agency to perform these surveys under SMARA. Some gravel, sand, and aggregate resources are found in close proximity to waterways and the LSJR in San Joaquin County (San Joaquin County 1998, City of Tracy 2005, City of Manteca 2003, City of Lathrop 2004). Most of the City of Stockton is designated as either not having mineral resources or a low likelihood of mineral resources (City of Stockton 2007). Other mineral resources, such as gold or peat, have been previously extracted from the county (San Joaquin County 1998). • Construction and operation of detention ponds would have a very low potential to result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally designated mineral resource recovery site. This is because these uses would be located within existing agricultural lands that are not used for mineral extraction. Impacts would not occur.

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Resource	Discussion
Noise	• Construction and operation of the detention ponds would occur in agricultural areas where there are limited sensitive receptors (e.g., schools, hospitals). Agricultural activities, which generate noise, are part of the existing noise conditions in actively farmed agricultural lands. Construction of detention ponds would be temporary and limited to ground-disturbing activities, and would be required to comply with existing local noise ordinances limiting the timing of construction (e.g., generally Mondays–Fridays, 7am–6pm). The lead agency with permitting approval over the ponds can and should implement potential mitigation measures identified in Table 16-38 or comparable to reduce potentially significant impacts associated with noise during construction of detention ponds. Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts could be mitigated to less than significant once mitigation measures were implemented given the temporary nature of construction, the short duration of construction, and the relatively small area of ground disturbance. • Construction activities that typical result in ground-borne vibrations or ground-borne noise are activities such as pile driving, where the ground is repeatedly struck and vibrations or noise can be generated. Given nature of construction to build a detention pond (e.g., digging and excavating) it is highly likely that pile driving would not occur or be needed. Impacts would be less than significant • Once operational, detention ponds would not produce noise as they would discharge agricultural return flows into receiving waters, which is not a noise-producing activity. As such, a permanent increase in ambient noise under operating conditions is not expected. Impacts would not occur. • While it is unknown where construction or operation of detention ponds might occur, the construction and operation of detention ponds would not bring new or additional people within close proximity to an airport or private airstrip or expose people to noise generated by air traffic on a regular basis. This is because detention ponds would not result in an increased permanent work force cited within proximity to an airport or private airstrip. Nor would detention ponds result in a population increase that would be exposed to airport noise. Impacts would not occur.
Population and Housing	• Construction and operation of detention ponds would not involve the construction of new homes or businesses, the extension of roads, or other actions that may induce substantial property growth in an area. Construction and operation of detention ponds would not develop any amenities (e.g., malls, amusement parks, hotels, recreation areas) that would attract people to the southern Delta. Impacts would not occur. • Construction and operation of detention ponds would not displace substantial numbers of people or housing, or necessitate the construction of replacement housing elsewhere because the change in volume of water (and timing of release of water) would take place at existing discharge points and agricultural lands, and not where people currently reside. Impacts would not occur.

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Resource	Discussion
Public Services	• The need for additional public services (e.g., fire protection, police protection, parks, libraries, schools) or the deterioration of existing public services typically results from an increase in population. As a location's population increases, the need for additional or new public services and public service facilities generally increases. As discussed in Population and Housing, above, construction and operation of the detention ponds would not involve an increase in population or housing. In addition, construction and operation of the ponds would not include proposals for new housing, and would not generate students or increase demands for school services or facilities. Impacts would not occur.
Recreation	• Recreational facilities are not typically located in agricultural fields, and construction and operation of detention ponds in agricultural lands would not result in impacts on recreational facilities or lead to the construction of recreational facilities. Impacts would not occur.
Transportation and Traffic	• Construction of detention ponds may involve construction vehicle trips. However, due to the limited geographic scale and limited duration of construction, it is not expected truck or worker trips would exceed local or regional road trip thresholds. Impacts would be less than significant. • Construction and operation of detention ponds would occur on existing agricultural land, which is generally not heavily trafficked and access would likely be restricted to the public. As such, it is not expected construction or operation would conflict with a regional congestion management program, would result in inadequate emergency access, conflict with existing public transit, public bicycle facilities, or public pedestrian facilities (e.g., sidewalks) or result in a hazard to on-road traffic. Once operational, they would not generate trips beyond what currently is generated on existing agricultural lands and as such would not conflict with the Regional Congestion Management Plan or local or regional trip thresholds. Impacts would not occur. • Construction and operation of detention ponds would not result in an increase demand for air traffic or the need for airports because these projects would not result in an increase in population and is not related to air traffic or airports. Impacts would not occur.
Utilities and Service Systems	• Construction and operation of detention ponds would not involve the need for utilities or service systems because it would not require the construction or operation of wastewater treatment facilities or water treatment supply facilities. It would not increase the demand for water and therefore new entitlements would not be needed. It would not result in the generation of solid waste. Impacts would not occur.

16.4.5 South Delta Temporary Barriers

The program of implementation for the SDWQ alternatives requires continued operations of the agricultural barriers at Grant Line Canal, Middle River, and Old River at Tracy, or other reasonable measures, to address the impacts of the CVP or SWP export operations on water levels and flow conditions that might affect salinity. The existing temporary barriers would likely to continue to operate in the southern Delta under the program of implementation. DWR determined it is essential to continue barrier installations to protect salmon migrating through the Delta, and to provide an adequate agricultural water supply for southern Delta farmers (DWR 2015b). An adequate agricultural water supply must satisfy quantity, quality, and channel water levels to meet the reasonable and beneficial needs of water users in the SDWA (DWR 2015b).

The purpose of operating the temporary barriers is to protect salmon migrating through the Delta and provide an adequate agricultural water supply in terms of quantity, quality, and channel water levels to meet the reasonable and beneficial needs of water users in the southern Delta area. The program is operated by DWR and also takes actions to protect agricultural diversions that are affected from the operations of the barriers. The program consists of four rock barriers across southern Delta channels that primarily benefit migrating fish or benefit agricultural water users.

- HOR – fish barrier
- Old River Near Tracy (ORT) – agricultural barrier
- Middle River (MR) – agricultural barrier
- Grant Line Canal (GLC) – agricultural barrier

The HOR barrier and has been in place most years since 1963 between September 15 and November 30. It was also installed in the spring between April 15 and May 30 of 1992, 1994, 1996, 1997, 2000, 2001, 2002, 2003, and 2004 and 2007 (high SJR flows prohibited installation in 1993, 1995, 1998, 1999, 2005, and 2006). The remaining three barriers and are installed between April 5 and September 30 of each season. The ORT barrier has been installed since 1991 and the MR barrier has been installed since 1987. A rock barrier in GLC was first installed in spring 1996, and has since been installed in 1997, 1999, and 2000 through the present. The four rock barriers were not installed in 1998 due to high SJR flows (DWR 2015c).

DWR maintains a publicly available schedule for the operation of the barriers. The schedule for 2015 is described in Table 16-33, *Temporary Barrier 2015 Schedule*, and generally follows seasonal timeframes and restrictions associated with fish and agriculture (DWR 2015d).

Table 16-33. Temporary Barrier 2015 Schedule

Barrier	Beginning of Onsite Work	Beginning of In-Water Work	Closure	Complete Removal
Spring Head of Old River	March 16, 2015	March 16, 2015	April 8, 2015	June 2015
Middle River	March 30, 2015	March 30, 2015	April 3, 2015	Early to Mid November 2015
Old River at Tracy	March 16, 2015	March 16, 2015	April 7, 2015	Mid to Late November 2015
Grant Line Canal	April 2, 2015	April 2, 2015	June 2015	Mid to Late November 2015
Fall Head of Old River	September 2015	September 2015	September 2015	Mid to Late November 2015

Source: DWR 2015d.

DWR identifies that water levels and water circulation in the southern Delta have improved with agricultural barrier installation. Migration conditions for salmon have improved when the HOR barrier was installed. As such, DWR determined it is essential to continue barrier installations to protect salmon migrating through the Delta, and to provide an adequate agricultural water supply for southern Delta farmers. An adequate agricultural water supply must satisfy quantity, quality, and channel water levels to meet the reasonable and beneficial needs of water users in the SDWA (DWR 2015c).

The temporary agricultural barriers maintain higher water elevations during ebb tides (water moving downstream towards the estuary) by blocking the tidal flow once the water elevation falls below the barrier crest. The crest elevation of the ORT and MR barriers are 1 foot higher than the GLC barrier, to create a slight upstream net flow towards Grant Line Canal as the tide elevation drops below the barrier crests. The minimum tidal elevations upstream of the barriers are thereby constrained by the GLC barrier crest, although the slight flow through the barriers allows a slowly decreasing elevation. The general effects of the barriers are such that the minimum daily elevations increase by about 2–3 ft during the period when the temporary barriers are installed.

The tidal flow during each ebb tide moves water one direction (towards the estuary) and the tidal flow during each flood tide moves water in the opposite direction (away from the estuary). Salinity will increase in a tidal channel having a higher salinity discharge (e.g., treated wastewater or agricultural drainage) both upstream and downstream; the increase in salinity will be less if the tidal flows are higher (from a greater tidal mixing volume) or if the net flow is higher (from greater dilution). The combination of tidal flows (mixing) with a net channel flow is sometimes called circulation; a null zone refers to a portion of a channel that has limited tidal flows and a small net flow, allowing salinity to accumulate from local drainage discharges. Tidal flow measurements at each of the temporary agricultural barriers show similar effects; the tidal flows upstream of the barriers are reduced to about 50 percent of the full tidal flows.

The salinity in the SJR at Vernalis is generally controlled by releases from New Melones Reservoir to meet the existing water quality objectives as described by the 2006 Bay-Delta Plan. Salinity generally increases downstream of Vernalis from the effects of agricultural drainage and treated wastewater discharges. Salinity along Old River between the SJR near Mossdale and Tracy Boulevard also generally increases from the City of Tracy wastewater discharge and many local discharges of agricultural drainage. Below is the cost evaluation and environmental evaluation for continuing to operate the South Delta Temporary Barriers, as described by the program of implementation for the SDWQ alternatives.

Cost Evaluation

The primary cost for the temporary barriers is driven by the activities, materials and equipment required to construct and remove them. Based on the DWR's multi-year (2016–2018) construction contract for the temporary barriers, DWR's estimated cost for constructing and removing the barriers for the 3-year period was approximately $11.8 million (DWR 2015e). This cost estimate includes labor, materials, equipment for construction and removal of the temporary rock barriers at MR, ORT, and GLC, and maintenance, refurbishment and/or replacement of appurtenances (e.g., temporary agricultural pumping facilities), as well as other related tasks, which could include furnishing, installing, and removing a non-physical barrier at Delta divergence locations (DWR 2015f). The contract was awarded for the lowest bid of $9.5 million (DWR 2015e).

Environmental Evaluation

The temporary barriers have been installed during their respective seasons for decades as described above. They are currently part of the baseline hydrology, water quality, and biological conditions of the southern Delta. They may continue to operate as they have been to maintain water levels and circulation in the southern Delta under the program of implementation. As such, DWR would continue to work with permitting agencies (e.g., U.S. Army Corps of Engineers) and resource agencies (e.g., Central Valley Water Board, NMFS, USFWS) to obtain the appropriate permits and conditions to operate the temporary barriers. As such, there would be no change from baseline conditions and there would be no environmental impacts with the continued operation of the temporary barriers.

16.4.6 Low Lift Pumping Stations

The program of implementation for the SDWQ alternatives requires additional studies and monitoring of the southern Delta circulation and water levels. It is possible that additional study and monitoring would determine the need for modifications of the existing South Delta Temporary Barriers Project. If this determination is made by the State Water Board, DWR may be required to install low lift pumping stations at the temporary barriers as a method of compliance.

Modifications could include providing additional lift stations at the barriers. DWR prepared the *Low-Head Pumping Conceptual Plan* (2011c) describing potential modifications to the operations of these barriers. Below is the cost evaluation and environmental evaluation performed by the *Low Head Pumping Conceptual Plan* for the installation of either permanent or temporary pumps at the South Delta Temporary Barriers.

Cost Evaluation

Cost evaluations were based on a number of layouts and scenarios. Costs were evaluated for stand-alone pumping sites or *single pumping sites* on each of the agricultural barriers in the southern Delta (ORT, MR, GLC). Costs were also evaluated for two pumping sites, or pumping sites on two of the three agricultural barriers (MR and ORT or MR and GLC). Three intake structure types were analyzed: temporary cylindrical, permanent cylindrical, and permanent flat intake screens. Lastly, pumping capacities were also analyzed with the above variables. The three analyzed pumping capacities were 250, 1,000, and 1,500 cfs. Tables 16-34, *Single Pumping Sites Estimated Initial Capital Costs*, through Table 16-37, *Two Pumping Sites Estimated Annual Costs*, show the costs of these potential methods of compliance.

The cost ranges are based on different site layout configurations analyzed in DWR's *Low-Head Pumping Conceptual Plan*. The site layout that would provide the greatest reduction in water quality violations is a two-pumping site alternative with 1,000 cfs pumping capacity combined pumping at MR and ORT barriers (DWR 2011c). The estimated cost of this layout is $55.5–$540.7 million; the estimated annual costs are $4.5–$62.7 million.

Table 16-34. Single Pumping Sites Estimated Initial Capital Costs

	Pump Capacity (cfs)		
Pump Facility Intake Screen Design	250	500	1,000
Temporary Cylindrical	$5.5–$20.7	$9.8–$40.9	$19.6–$80.9
Permanent Cylindrical	$20.2–$60.8	$40.9–$112.9	$81.7–$234.3
Permanent Flat	$120– $161.4	$214.5–$286.6	$391.7–$551

Source: DWR 2011c.
Note: All cost values in millions of dollars.
cfs = cubic feet per second.

Table 16-35. Two Pumping Sites Estimated Initial Capital Costs

	Pump Capacity (cfs)		
Pump Facility Intake Screen Design	250	500	1,000
Temporary Cylindrical	$14.9	$28.4	$55.5
Permanent Cylindrical	$49.5	$87.6	$168.1
Permanent Flat	$186.9	$301.0	$540.7

Source: DWR 2011c.
Note: All cost values in millions of dollars.
cfs = cubic feet per second.

Table 16-36. Single Pumping Sites Estimated Annual Costs

	Pump Capacity (cfs)		
Pump Facility Intake Screen Design	250	500	1,000
Temporary Cylindrical	$10–$22.6	$15.6–$45.1	$32.4–$89.9
Permanent Cylindrical	$0.7–$1.4	$1.4–$2.6	$2.7–$5.3
Permanent Flat	$3.4–$4.5	$6.1–$8.5	$11.8–$16.3

Source: DWR 2011c.
Note: All cost values in millions of dollars.
cfs = cubic feet per second.

Table 16-37. Two Pumping Sites Estimated Annual Costs

	Pump Capacity (cfs)		
Pump Facility Intake Screen Design	250	500	1,000
Temporary Cylindrical	$17.8	$33.5	$62.7
Permanent Cylindrical	$1.3	$2.3	$4.5
Permanent Flat	$4.7	$8.0	$14.7

Source: DWR 2011c.

Note: All cost values in millions of dollars.

cfs = cubic feet per second.

Environmental Evaluation

As part of the *Low-Head Pumping Conceptual Plan* (2011b), DWR prepared an environmental checklist documenting potential impacts on environmental resources should the conceptual plan be implemented. The environmental checklist and analysis identified environmental commitments and/or potential mitigation measures to be implemented by DWR, should the project move forward, to reduce potentially significant impacts for the following resources associated with either construction or operation: aesthetics, agriculture, air quality, biological resources, cultural resources, geology and soils, GHG emissions, hazards and hazardous materials, hydrology and water quality, land use and planning, noise, transportation and traffic, and utilities and service systems. The environmental checklist identified less-than-significant impacts for the following resources: mineral resources, population and housing, public services, and recreation. Attachment 4 of Appendix H, *Supporting Materials for Chapter 16*, contains the environmental checklist of the conceptual plan and is incorporated into this evaluation. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, at the end of this chapter, lists potential mitigation measures that DWR can and should implement to reduce potentially significant environmental effects on environmental resources. It is likely that those impacts related to construction could be mitigated to less than significant once mitigation measures were implemented due to the temporary nature of construction, the relative short duration of construction, and the relatively small area of ground disturbance. However, given the potential need to construct a cofferdam and dewater, there is the potential for take of listed fish species (similar to coffer dams required and described in Section 16.3.6, *Fish Passage Improvements – Fish Screens*, Section 16.3.7, *Fish Passage Improvements – Physical Barriers in the Southern Delta*, and Section 16.3.9, *Predatory Fish Control*). As such, even with mitigation measures, significant and unavoidable impacts may occur if the potential for take cannot be avoided or reduced or take occurs during construction. In addition, as described in Tables 16-12 and 16-21, the generation of GHGs during construction and operation may not be lessened with mitigation measures and as such, may result in exceedances of existing air quality management basin thresholds that cannot be mitigated to less-than-significant levels.

16.5 Sources of Funding

There are many financial assistance programs designed to assist agencies implement water supply and water quality projects. The federal and state governments manage these programs. Often, these funding programs can leverage each other to make a project more feasible. Below is a brief description of some pertinent funding programs.

16.5.1 Federal Sources

U.S. Department of Agriculture

Water and wastewater loans and grants are offered through U.S. Department of Agriculture (USDA) Rural Development. Eligible applicants are public entities, nonprofit organizations, federally recognized tribes, and mutual water companies located outside cities, with a population under 10,000 people. Financial assistance recipients may receive a grant and loan component. The grant component cannot exceed 75 percent of the total financial assistance requested. Loans are offered up to a 40-year term at an interest rate updated quarterly, based on nonmetropolitan median household income (CFCC 2012).

U.S. Department of the Interior, Bureau of Reclamation

The Water Sustain and Manage America's Resources for Tomorrow (Water SMART) Program is an umbrella program that manages many grant programs for water supply research and implementation projects. The core focus of Water SMART is sustainable management and water efficiency. Typical projects include projects to reduce water losses in distribution systems, water recycling projects, and the creation of new water sources for agricultural irrigation purposes. Water SMART has multiple funding opportunities for municipal and agricultural water users. Typical grant awards range from $200,000 to $1,500,000 (CFCC 2012).

The U.S. Department of the Interior, Bureau of Reclamation (USBR) also offers grant programs targeted at improving the Bay-Delta's water resources and water quality through the Bay-Delta Restoration Water Use Efficiency Grants Program. Funds are available for improving water supply reliability and for increasing water use efficiency. Eligible applicants are public entities with authority over water delivery located within the CALFED solution area as identified in the 1999 *CALFED Programmatic Environmental Impact Statement/ Environmental Impact Report* (CALFED 2000a, CFCC 2012).

16.5.2 State Sources

California Infrastructure and Economic Development Bank

The Infrastructure State Revolving Fund finances water supply and water quality projects. Financial assistance is available in the form of lower-than-market interest rate loans. Based on a project description and applicant's credit score, an interest rate is computed. The term of the loan can be up to 30 years. Eligible applicants include public entities, such as cities, counties, and special districts (CFCC 2012).

California Department of Water Resources

The Agricultural Water Use Efficiency Grant Program provides funds for projects that improve agricultural water use efficiency. Projects must result in water savings, increased in-stream flow, increased water quality, or increased energy efficiency in water systems. Sample projects include: feasibility studies, research, development, training, education, public outreach, and pilot projects (CFCC 2012).

Integrated Regional Water Management (IRWM) provides funds for many types of water quality activities. Current IRWM grant programs include: planning, implementation, and storm water flood management. IRWM grants focus on holistic watershed management activities and regional coordination of water supplies. Eligible applicants include cities, counties, districts, and nonprofit organizations (CFCC 2012).

DWR manages the Delta and San Joaquin and Sacramento Rivers Water Quality Grant Program to assist agencies with projects that protect drinking water supplies. Eligible projects include: (1) projects that reduce or eliminate discharges of salt, dissolved organic carbon, pesticides, pathogens, and other pollutants to the SJR; (2) projects that reduce or eliminate discharges of bromide, dissolved organic carbon, salt, pesticides, and pathogens from discharges to the Sacramento River; (3) projects at Franks Tract and other locations in the Delta that will reduce salinity or other pollutants at agricultural and drinking water intakes; and (4) projects identified in the June 2005 *Delta Region Drinking Water Quality Management Plan*, prioritizing design and construction of the relocation of drinking water intake facilities for in-Delta water users (CFCC 2012).

State Water Resources Control Board

The Clean Water State Revolving Fund provides low-interest loans for water quality improvement projects, including water recycling and desalination. The loan term is up to 30 years, and the interest rate is between 0 percent and half the general obligation bond rate (2.4–3 percent) depending on the applicant's population and median household income. Principal forgiveness is available for small disadvantaged communities. Typical loans are for 20 years at half the State's general obligation bond rate. Eligible applicants are cities, counties, special districts, and joint powers authorities (CFCC 2012).

Water recycling projects that offset potable water supplies are eligible to apply for financial assistance from the Water Recycling Funding Program (WRFP). WRFP has funds available to assist with planning and implementation of water recycling projects. Only public entities (e.g., cities, counties, special districts) are eligible to apply for these funds. The WRFP offers both grants and loans (CFCC 2012).

The Agricultural Drainage Loan and Agricultural Drainage Management Loan Programs provide funding for projects that address treatment, storage, conveyance, or disposal of agricultural drainage that threatens waters of the State. An example project is the installation of tailwater recirculation systems and drip irrigation systems to reduce the volume of tailwater and contaminants discharged to a receiving waterbody. Eligible applicants include public entities (e.g., cities, counties), districts, joint powers authority, or other political subdivisions of the State involved with water management (CFCC 2012).

Department of Public Health

The Safe Drinking Water State Revolving Fund provides low-interest loans for projects that correct and upgrade drinking water infrastructure. The loan term is up to 30 years, and the interest rate is between 0 percent and half the general obligation bond rate (2.4–3 percent) depending on the applicant's population and median household income. Principal forgiveness is available for small disadvantaged communities. Typical loans are for 20 years at half the State's general obligation bond rate. Eligible applicants are cities, counties, special districts, and joint powers authorities (CFCC 2012).

16.6 Potential Mitigation Measures

This section summarizes potential mitigation measures that could be applied by lead agencies or other entities to reduce potentially significant impacts identified in the environmental evaluations of Sections 16.2, *Lower San Joaquin River Alternatives – Other Indirect Actions*, 16.3, *Lower San Joaquin River Alternatives – Non-Flow Measures,* and 16.4, *Southern Delta Water Quality Alternatives – Reasonably Foreseeable Methods of Compliance*. These potential mitigation measures were developed based on a review of similar projects. The scope, scale, and location of a particular project would dictate the need for, and the type of, mitigation. While the particular circumstances and location of a project may result in significant and unavoidable impacts post mitigation, lead agencies and entities may be able to fully mitigate impacts to a less-than-significant level (using one or more of the potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*). In addition, as required by CEQA (State CEQA Guidelines § 15126.2) lead agencies and entities would describe a reasonable range of alternatives based on project-specific conditions and project-specific objectives, and one of the alternatives may, in and of itself reduce significant environmental impacts. The effectiveness of mitigation is contingent upon several other factors, such as those listed below.

- The ability of lead agencies and entities to implement the mitigation.
- The other responsible agencies involved in the project.
- The thresholds lead agencies use to evaluate the impact.
- Site-specific conditions.

This section first summarizes those mitigation measures that could be applied to other indirect actions and methods of compliance and then summarizes mitigation measures that could be applied to non-flow measures.

16.6.1 Other Indirect Actions and Methods of Compliance

The other indirect actions that could occur under the LSJR alternatives and the reasonably foreseeable methods of compliance that could occur under the SDWQ alternatives, discussed herein, would be subject to project-specific CEQA review prior to approval. The project-specific analysis would be required to identify potentially significant environmental impacts. The lead agency would be required to require the implementation of all feasible mitigation measures to reduce impacts to less than significant or be responsible for providing a statement of overriding considerations for significant impacts that cannot be mitigated to a level of less than significant. Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, identifies the potential mitigation measures that lead agencies could implement should they determine a discretionary action they approve has significant impacts. These mitigation measures are based, in part, on mitigation measures presented in the following documents.

- *Proposed Amendment to the Water Quality Control Plan for the North Coast Region to Establish Exception Criteria to Point Source Waste Discharge Prohibition by Raising the Action Plan for Storm Water Discharges and Adding a New Action Plan for Low Threat Discharges* (North Coast Regional Water Quality Control Board 2009).
- *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento and San Joaquin Delta Estuary* (Central Valley Water Board 2010a).
- *Substitute Environmental Document for Toxic Pollutants in the Dominguez Chanel and Greater Los Angeles and Long Beach Waters Total Maximum Daily Load* (California Regional Water Quality Control Board, Los Angeles Region 2011).
- *Initial Study and Mitigated Negative Declaration for the Tracy Desalination and Green Energy Project* (City of Tracy 2011).
- *Irrigated Lands Regulatory Program Environmental Impact Report* (Central Valley Water Board 2010b).
- Low Head Pump Salinity Control Study Prepared to Meet Requirements of the State of California State Water Resources Control Board Water Rights Order WR 2010-0002, Condition A.7. Appendix C: Environmental Considerations for South Delta Low Head Pump Station (DWR 2011c).
- *Water Supply Options* (SFPUC 2007).

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(d).) Feasible mitigation measures are intended to avoid, reduce, or compensate for adverse impacts on a resource and can include actions such as implementation of plans to minimize impacts. For each impact identified as significant, a mitigation measure to reduce that impact to a less-than-significant level is described, if appropriate, or the infeasibility of mitigation is discussed. One legal factor that may render a mitigation measure infeasible is the limited authority of the lead agency. CEQA does not grant agencies new, discretionary powers independent of the powers granted to the agencies by other laws. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040.) Accordingly, a mitigation measure may be legally infeasible if the lead agency does not have the discretionary authority to implement it. In addition, economic considerations may render mitigation measures infeasible. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, §§ 15040, 15041, 15126.4, 15364.) The authority to require project-level mitigation lies with the lead agencies undertaking or approving the individual projects, not the State Water Board. These agencies can and should impose the mitigation measures presented in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions*, and until such time that these mitigation measures are imposed, impacts would remain significant, consistent with State CEQA Guidelines Section 15091. Potential mitigation measures associated with water transfers discussed in Section 16.2.1, *Transfer/Sale of Surface Water*, are summarized in Attachment 1 of Appendix H, *Supporting Materials for Chapter 16*. Potential mitigation measures associated with Water Supply Desalination discussed in Section 16.2.6, *Water Supply Desalination*, are summarized in Attachment 3 of Appendix H, *Supporting Materials for Chapter 16*.

Table 16-38. Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions[a]

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
Construction											
Aesthetics	• Direct construction lighting away from residential and roadway areas if sensitive receptors are present.[2]	X	—	X	—	X	X	X	X	—	X
	• Implement a revegetation plan to revegetate areas where construction-related ground disturbance has occurred.	—	—	X	—	X	X	X	X	—	X
	• Design facility to blend with surrounding land uses.	—	—	—	X	X	X	—	X	—	X
	• Use appropriate architectural treatment and landscaping.	—	—	—	X	X	X	—	X	—	X
	• Reservoir management plan to incorporate elevation/storage levels to accommodate recreational access to the extent practicable.	—	—	—	—	X	—	—	—	—	—
Agriculture and Forestry Resources	• If forest or vegetation is removed by a qualified forester or restoration ecologist and reviewed by the appropriate agencies, develop and implement a reforestation and/or revegetation plan.[2]	—	—	—	—	—	X	—	X	—	—
	• Restrict ground-disturbing mechanical operations around sensitive forested or agricultural areas.[2]	—	—	X	X	X	X	—	X	—	X
	• Preserve or replace onsite trees as a means of maintaining forest resource(s) and providing carbon storage (afforestation/reforestation).[2]	—	—		—	X	X	—	X	—	X
	• Avoid agricultural lands (including Prime Farmland, Unique Farmland, and Farmland of Statewide Importance) or timber production zone lands or National Forest System lands to the greatest extent possible.[6]	—	—	X	X	X	X	X	X	X	X
	• Develop a plan that mitigates to the maximum extent practicable for lands inundated by new surface water storage to reduce impacts on forestry resources.	—	—	—	—	X	—	—	—	—	—
	• Coordinate with applicable counties and local jurisdictions to determine if there is an agricultural mitigation program and comply with mitigation the program to the extent required by law. For example, San Joaquin County's agricultural mitigation ordinance (Title 9, Division 10, Chapter 9-1080) requires agricultural mitigation for an amendment to the general plan or a zoning reclassification that changes the designation of any land from agricultural to nonagricultural use. Mitigation is satisfied by granting a farmland conservation easement or other farmland conservation mechanism, and the number of acres of agricultural mitigation land must be at least equal to the number of acres converted to a nonagricultural use (1:1 ratio). The City of Tracy, pursuant to an agricultural mitigation fee ordinance (Municipal Code Title 13, Chapter 13.28), requires payment of a fee for each acre of farmland to be developed for private urban uses. The fees are used for the purchase of conservation easements on agricultural lands. Similarly, the City of Stockton's Agricultural Land Mitigation Program requires that all projects under the City's jurisdiction that would result in the conversion of agricultural land to nonagricultural uses to either dedicate an in-kind direct	—	—	—	—	—	X	—	X	—	—

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	purchase/acquisition of an agricultural conservation easement at a 1:1 ratio or pay an in-lieu agricultural land mitigation fee.										
Air Quality	• Apply appropriate construction mitigation measures from the applicable air district (e.g., SJVAPCD) to reduce construction emissions. These measures will be applied on a project-level basis and may be tailored in consultation with the appropriate air district, depending on the severity of anticipated construction emissions. [5] ○ CCAPCD: – The applicant shall be responsible for ensuring that all adequate dust control measures are implemented in a timely manner during all phases of project development and construction. – All material excavated, stockpiled, or graded shall be sufficiently watered, treated, or covered to prevent fugitive dust from leaving the property boundaries and causing a public nuisance or a violation of an AAQS. Watering should occur at least twice daily, with complete site coverage. – All areas with vehicle traffic shall be watered or have dust palliative applied as necessary for regular stabilization of dust emissions. – All onsite vehicle traffic shall be limited to a speed of 15 miles per hour on unpaved roads. – All land clearing, grading, earth moving, or excavation activities on a project shall be suspended as necessary to prevent excessive windblown dust when winds are expected to exceed 20 miles per hour. – All inactive portions of the development site shall be covered, seeded, or watered until a suitable cover is established. Alternatively, the applicant may apply County-approved nontoxic soil stabilizers (according to manufacturer's specifications) to all inactive construction areas (previously graded areas which remain inactive for 96 hours) in accordance with the local grading ordinance. – All material transported offsite shall be either sufficiently watered or securely covered to prevent public nuisance, and there must be a minimum of 6 inches of freeboard in the bed of the transport vehicle. – Paved streets adjacent to the project shall be swept or washed at the end of each day, or more frequently if necessary, to remove excessive or visibly raised accumulations of dirt and/or mud which may have	X	—	X	X	X	X	X	X	—	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	resulted from activities at the project site. – Prior to final occupancy, the applicant shall re-establish ground cover on the site through seeding and watering in accordance with the local grading ordinance. – In addition, the CCAPCD recommends the following mitigation measures, which may be applicable to a proposed project: o Mitigation for Use during Design and Construction Phases: – Grid power shall be used (as opposed to diesel generators) for job site power needs where feasible during construction. – Temporary traffic control shall be provided during all phases of construction to improve traffic flow as deemed appropriate by local transportation agencies and/or Caltrans. – Construction activities shall be scheduled to direct traffic flow to off-peak hours as much as practicable. – During initial grading, earth moving, or site preparation, larger projects may be required to construct a paved, coarse gravel, or dust palliative treated apron, at least 100 ft in length, leading onto the paved road(s). – Wheel washers may be required where project vehicles and/or equipment enter and/or exit onto paved streets from unpaved roads on larger projects. – All self-propelled off-road diesel-powered equipment and vehicles greater than 25 bhp shall be equipped with an engine meeting at least Tier 1 emission standards (typically manufactured 1996 or later). o GBUAPCD: – Use, where possible, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads or the clearing of land. – Application of asphalt, water, or suitable chemicals on dirt roads, material stockpiles, and other surfaces which can give rise to airborne dusts. – Installation and use of hoods, fans, and fabric filters, to enclose and vent the handling of dusty materials. Adequate contaminant methods shall be employed during such handling operations. – Use of water, chemicals, chuting, venting, or other precautions to prevent particulate matter from										

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	becoming airborne in handling dusty materials to open stockpiles and mobile equipment. – Maintenance of roadways in a clean condition. o MCAPCD: – Maintaining construction vehicles and equipment according to manufacturers [sic] specifications. – Limiting equipment idling time. – Scheduling construction truck work trips to non-peak traffic hours. – Minimizing the length of construction truck trips. – Using water or chemicals to control dust from demolition, construction, or grading. – Applying asphalt, oil, water, or suitable chemicals on unpaved roads, material stockpiles or other surfaces. – Installation of hoods, fans and filters to enclose and vent the handling of dusty materials. – Using water, chemicals, chuting, venting, or other precautions when handling dusty materials in open stockpiles and mobile equipment. – Maintaining paved roadways in a clean condition. o TCAPCD (from the Tuolumne County General Plan Update EIR [Tuolumne County 2015]): – Exposed soils shall be watered as needed to control wind borne dust. – Exposed piles of dirt, sand, gravel, or other construction debris shall be enclosed, covered and/or watered as needed to control wind borne dust. – Vehicle trackout shall be minimized through the use of rubble strips and wheel washers for all trucks and equipment leaving the site. – Sweep streets once a day if visible soil materials are carried to adjacent streets (recommend water sweepers with reclaimed water). – Onsite vehicle speed shall be limited to 15 miles per hour on unpaved surfaces. – Loads on all haul/dump trucks shall be covered securely or at least 2 ft of freeboard shall be maintained on trucks hauling loads. – Construction equipment shall be maintained and tuned at the interval recommended by the manufacturers to										

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	minimize exhaust emissions. – Equipment idling shall be kept to a minimum when equipment is not in use. – Construction equipment shall be in compliance with the ARB off-road and portable equipment diesel particulate matter (DPM), regulations. – Substitute electrical equipment for diesel- and gasoline-powered equipment where practical. – Use alternatively fueled construction equipment onsite, where feasible, such as compressed natural gas (CNG), liquefied natural gas (LNG), propane, or biodiesel. – Avoid the use of onsite generators by connecting to grid electricity or utilizing solar-powered equipment. – Limit heavy-duty equipment idling time to a period of 3 minutes or less, exceeding the ARB regulation minimum requirements of 5 minutes.										
	• Apply appropriate Toxic Air Contaminants (TAC) and Hazardous Air Pollutants (HAP) mitigation measures from the applicable air district to reduce public exposure to DPM pesticides, and asbestos. These measures are documented in official rules and guidance reports; however, not all districts make recommendations for mitigation measures for TAC/HAP emissions. These measures will be applied on a project-level basis and may be tailored in consultation with the appropriate air district, depending on the severity of anticipated TAC/HAP emissions.[5]	X	—	X	X	X	X	X	X	—	X
	• Use vehicles with zero-emission or lower-emission engines.[2]	X	—	X	—	X	X	X	X	—	—
	• Limit the unnecessary idling of vehicles and equipment.[2]	X	—	X	—	X	X	X	X	—	X
	• Use low/zero carbon/alternative fuels, such as B20 biodiesel or renewable diesel.[2]	X	—	X	—	X	X	X	X	—	X
	• Control visible emissions from off-road diesel powered equipment.[2]	X	—	X	—	X	X	X	X	—	X
	• Design structural devices to minimize the frequency of maintenance trips.[2]	X	—	X	—	X	X	X	X	—	X
	• Perform necessary equipment maintenance, such as inspections and corrections, to detect failures early; keep equipment operating cleanly and efficiently. [2]	X	—	X	—	X	X	X	X	—	X
	• Use the proper sized equipment for the job during construction and operation.[2]	X	—	X	—	X	X	X	X	—	X
	• Train equipment operators in proper use of equipment during construction and operation.[2]	X	—	X	—	X	X	X	X	—	X
	• Produce concrete onsite if determined to be less emissive than transporting ready mix.[2]	X	—	X	—	X	X	X	X	—	X
	• Minimize the amount of concrete for paved surfaces or utilize a low-carbon concrete option.[2]	X	—	X	—	X	X	X	X	—	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Use locally sourced or recycled materials for construction materials.[2]	X	—	X	—	X	X	X	X	—	X
	• Control fugitive dust emissions during land clearing, grubbing, scraping, excavation, leveling, grading, or cut and fill operations with application of water (at least twice daily) or by presoaking.[2, 4]	X	—	X	X	X	X	X	X	—	X
	• Cover stockpiles of soil, sand, and other materials, and stabilize all disturbed areas and storage piles that are not being actively utilized for construction purposes using water, chemical stabilizers, or by covering with tarps, other suitable cover, or vegetative ground cover.[2, 4]	X	—	X	X	X	X	X	X	—	X
	• Pave, apply water, or apply soil stabilizers to unpaved areas, including all access roads and parking areas.[2, 4]	X	—	X	—	X	X	X	X	—	X
	• Sweep surrounding streets and paved areas (e.g., once per day).[2]	X	—	X	—	X	X	X	X	—	X
	• Suspend excavation and grading activity when winds (instantaneous gusts) exceed 25 miles per hour and/or greater than 20 miles per hour over a 1-hour period.[2, 4]	X	—	X	—	X	X	X	X	—	X
	• Initiate landscaping and revegetation as soon as construction tasks allow in order to minimize wind erosion.[2]	X	—	X	—	X	X	X	X	—	X
	• Encourage ride sharing and use of transit transportation for construction employees commuting to the project site.[4]	X	—	X	—	X	X	X	X	—	X
	• Use electric equipment for construction whenever possible in lieu of fossil fuel–powered equipment.4	X	—	X	—	X	X	X	X	—	X
	• Discontinue all construction activities during first stage smog alerts, first stage ozone alerts, and/or curtail construction during periods of high ambient pollutant concentrations.[4]	X	—	X	—	X	X	X	X	—	X
	• Water previously disturbed exposed surfaces (soil) a minimum of 3 times per day or whenever visible dust is capable of drifting from the site or approaches 20 percent opacity.[4]	X	—	X	X	X	X	X	X	—	X
	• Water all haul roads (unpaved) a minimum of 3 times per day or whenever visible dust is capable of drifting from the site or approaches 20 percent opacity.[4]	X	—	X	X	X	X	X	X	—	X
	• Reduce speed on unpaved roads to less than 15 miles per hour.[4]	X	—	X	—	X	X	X	X	—	X
	• Install and maintain a trackout control device that meets the specifications of regional air board requirements if needed (e.g., SJVAPCD Rule 8041 if the site exceeds 150 vehicle trips per day or more than 20 vehicle trips per day by vehicles with three or more axles).[4]	X	—	X	—	X	X	X	X	—	X
	• Cover trucks hauling debris, soil, sand, or other material to reduce dust and suspended air particles, and when transporting materials offsite, maintain a freeboard limit of at least 6 inches or effectively wet to limit visible dust emissions.[4,2]	X	—	X	X	X	X	X	X	—	X
	• Limit and remove the accumulation of mud and/or dirt from adjacent public roadways at the end of each workday.[4]	X	—	X	—	X	X	X	X	—	X
	• Remove visible trackout from the site at the end of each workday.[4]	X	—	X	—	X	X	X	X	—	X
	• Comply with applicable regional air board asphalt-concrete paving	X	—	X	X	X	X	X	X	—	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	rules such as SJVAPCD Rule 4641 (e.g., restrict use of cutback, slow-sure, and emulsified asphalt paving materials).[4]										
	• Install diesel particulate filter and utilize diesel oxidation catalyst.[6]	—	—	—	—	X	—	—	—	—	X
	• Require the pump system be electric or alternatively fueled.[6]	—	—	—	—	X	—	—	—	—	X
	• Locate pump system/emissions generating activity as far from sensitive receptors as possible.[6]	X	—	X	—	X	X	X	X	—	X
Biological Resources[b]	• Prior to land disturbance, contact USFWS and CDFW (or appropriate land management agency, such as national forests and Bureau of Land Management) and conduct all necessary pre-construction surveys for special-status plants, species, and habitat prior to construction activities. This may include the hiring of a qualified biologist to identify riparian and other sensitive vegetation communities and/or habitat for special-status plants and animals.[1,5,6]	X	—	X	X	X	X	X	X	X	X
	• Comply with local, state, and federal regulations and ordinances such as those listed below.	X	—	X	X	X	X	X	X	X	X
	○ USFWS ESA Section 7 consultation for threatened and endangered species.[2]										
	○ U.S. Army Corps of Engineers Clean Water Act Section 404 Permit and State Clean Water Act Section 401 Water Quality Certification for filling or dredging waters of the United States and other federal permitting actions.[2, 5]										
	○ CDFW California Fish and Game Code 1601 Agreement for Streambed Alteration.[2]										
	○ State Water Board WDRs (which are also permits for purposes of the Clean Water Act, if applicable).[2]										
	○ General plan or National Forest System land or Bureau of Land Management conservation requirements.[2]										
	○ City and/or county tree ordinances.[2]										
	○ Contract with qualified botanists, wildlife biologists, and arborists to develop biological assessments if a project's specific location warrants doing so. At a minimum, assessments should include project area-specific literature searches, reviews of CDFW's California Natural Diversity Database and the California Native Plant Society's Inventory of Rare and Endangered Plants of California, and field surveys of all potential project sites and their surrounding areas to identify and map existing plant communities, wildlife habitat, and heritage trees, and to identify wildlife species that currently occur, have occurred in the past (e.g., resident and migratory wildlife species that have been documented as foraging or nesting at the site), or have the potential to occur at the site due to the presence of suitable habitat. Field surveys should follow protocols established by CDFW and should be conducted during the appropriate time(s) of year (e.g., during the blooming period of potentially occurring plant species).[2,5]	X	—	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Select a project site that does not contain critical habitat if there are project site alternatives. Or locate project facilities outside the boundaries of critical habitat areas if there is only one project site available.[2, 5]	X	—	X	X		X	X	X	X	X
	• Avoid and minimize disturbance of riparian and other sensitive vegetation communities.[5]	X	—	X	X	X	X	X	X	X	X
	• Avoid and minimize disturbance of areas containing special-status plant or animal species.[5]	X	—	X	X		X	X	X	X	X
	• Where adverse effects on sensitive biological resources (including fish species) cannot be avoided, undertake additional CEQA review and develop a restoration or compensation plan to mitigate the loss of the resources.[5]	X	—	X	—	X	X	X	X	X	X
	• Where construction in areas that may contain special-status fish species cannot be avoided through the use of alternative management practices, conduct an assessment of habitat conditions and the potential for presence of special-status fish species prior to construction; this may include the hiring of a qualified fish biologist to determine the presence of special-status fish species.[5]	X	—	X	—	X	X	X	X	X	X
	• Based on the species present in adjacent waterbodies and the likely extent of construction work that may affect fish, limit construction to periods that avoid or minimize impacts on special-status fish species.[5]	X	—	X	—	X	X	X	X	X	X
	• Develop a mitigation and management plan in coordination with CDFW and USFWS to implement all appropriate measures as required by USFWS ESA Section 7 consultation and to satisfy any other local, state, and federal requirements for achieving no net loss of wetlands or other critical habitat, or take of wildlife species of concern. The plan should be submitted to the local city/county environmental planning department, USACE, USFWS, CDFW, applicable regional water quality control board (e.g., as part of a Section 401 Water Quality Certification application), and/or other oversight agencies as applicable for approval prior to its implementation if an impact on special-status species population(s) is determined to occur based on the biological assessment and evaluation of the final project site and design.[2]	X	—	X	X	X	X	X	X	X	X
	• Develop a revegetation plan if vegetation would be disturbed during construction or operation. The revegetation plan should be prepared by a qualified restoration ecologist and reviewed by the appropriate agencies. The plan should specify sites where revegetation should take place, the planting stock appropriate for the region, appropriate designs (e.g., plant arrangements that, when mature, replicate the natural structure and species composition of similar habitats in the region), planting techniques, monitoring frequency, and success criteria (e.g., sapling trees no longer require active management).[2]	X	—	—	—	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Establish temporary construction buffers for drainages, wetlands/vernal pools, and other sensitive habitat in the project area that could be affected by construction activities. The outer edges of the buffer zones will be demarcated using flagging or temporary orange mesh construction fencing before initiation of construction activities and based on site-specific conditions, seasonal restrictions for wildlife, local planning department specifications, and resource agency (e.g., USFWS and CDFW) requirements.[2,6]	X	—	X	X	X	X	X	X	X	X
	• Require a qualified biologist to perform the following construction functions if sensitive habitat or species are present. ○ Perform required preconstruction surveys to determine the current presence of, and demarcate the boundaries of construction buffers around, sensitive habitats, and submit survey reports according to CDFW and local agency guidelines for approval prior to construction.[1,2,5,6] ○ Provide USFWS-approved worker environmental awareness training that informs all construction personnel about sensitive plant and wildlife species and habitats.[2] ○ Oversee major excavation and other construction activities with the authority to stop construction activities until appropriate corrective measures have been completed.[2] ○ Report to USFWS any incidental take.[2] ○ Periodically re-inspect the project site (e.g., every week) during construction activities or whenever a there has been a substantial lapse in construction activity (e.g., more than 2 weeks).[2]	X	—	X	X	X	X	X	X	X	X
	• Locate temporary access roads and staging areas outside the boundaries of critical habitat areas, restrict movement of heavy equipment to and from the project site to established roadways and areas designated for construction and staging, and do not allow parking of vehicles or storage of potentially toxic chemicals near or up-gradient of drainages or sensitive habitats or under heritage trees.[2]	X	—	X	X	X	X	X	X	X	X
	• Implement measures to control dust, erosion, and noise (see the Air Quality, Geology and Soils, and Noise sections, respectively). [2]	X	—	X	X	X	X	X	X	X	X
	• Properly contain or remove all trash that may attract predators to the worksite during construction.[2]	X	—	X	—	X	X	X	X	X	X
	• Remove any temporary fill and construction debris and, wherever feasible, restore disturbed areas to pre-project conditions according to the before-mentioned revegetation plan after completion of construction activities.[2]	X	—	X	—	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Provide compensation for unavoidable degradation or loss of critical habitat due to project construction to ensure no net loss of that habitat as required by local, state, or federal agencies. Compensation could be provided at a minimum ratio (e.g., 3:1, 3 acres of restored wetlands for every 1 acre affected, or three native oak trees planted for every native oak tree eliminated) that ensures long-term replacement of habitat functions and values and complies with local, state, and federal requirements. Examples of compensation are as follows. ○ Construct replacement habitat as close as possible to the previous habitat location at the project site (e.g., locate replacement riparian and wetland habitats along the same drainage affected by the project construction). ○ If site limitations prevent onsite habitat replacement, construct replacement habitat as near the project site as possible. ○ Provide payment on a per-acre basis to an approved restoration or mitigation bank or other trust fund.[2]	X	—	X	—	X	X	X	X	X	X
	• Comply with measures contained within habitat conservation plans or natural community conservation plans, such as the San Joaquin Multi-Species Habitat Conservation and Open Space Plan. Consult with appropriate biologists who have training and are knowledgeable about the habitat conservation plan or natural community conservation plan. Monitoring, construction, and relocation surveys by a qualified biologist would be done as appropriate.[4]	X	—	X	X	—	X	X	X	X	X
	• Prior to implementing any management practice that would result in the permanent loss of wetlands, conduct a delineation of affected wetland areas to determine the acreage of loss in accordance with current USACE methods. For compliance with the Clean Water Act Section 404 permit and WDRs, compensate for the permanent loss (fill) of wetlands and ensure no net loss of habitat functions and values. Compensation ratios will be determined through coordination with the Central Valley Water Board and U.S. Army Corps of Engineers as part of the permitting process. Compensation may be a combination of mitigation bank credits and restoration/creation of habitat, as described below. ○ Purchase credits for the affected wetland type (e.g., perennial marsh, seasonal wetland) at a locally approved mitigation bank and provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. ○ Develop and ensure implementation of a wetland restoration plan that involves creating or enhancing the affected wetland type.[5]	X	—	X	X	X	X	X	X	X	X
	• Install species exclusion fencing for animal species during construction; install a temporary, plastic mesh-type construction fence at least 1.2 m tall around any established special-status plant species buffer areas to prevent encroachment by construction vehicles and personnel; a qualified biologist will determine the exact	—	—	X	X	X	—	—	—	—	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	location of the fencing.[6]										
	- Conduct pile driving with vibratory hammer.[6]	—	—	—	—	X	—	—	—	—	X
	- Implement turbidity monitoring during construction/removal.[6]	—	—	—	X	X					X
	- Implement environmental awareness program for construction personnel.[6]	—	—	—	X	X	—	—	—	—	X
Cultural Resources	- Where construction within areas that may contain cultural resources cannot be avoided through the use of alternative management practices, conduct an assessment of the potential for damage to cultural resources prior to construction; this may require the hiring of a qualified cultural resources specialist to determine the presence of significant cultural resources.[5]	—	—	X	X	X	X	X	X	X	X
	- Where the assessment indicates that damage may occur, and prior to land disturbance, submit a non-confidential records search request to the appropriate California Historic Resources Information System (CHRIS) which potentially includes the following in the plan area.[1,5]	—	—	X	—	X	X	X	X	X	X
	○ Alpine County: Central California CHRIS Information Center										
	○ Calaveras County: Central California CHRIS Information Center[5]										
	○ Contra Costa County: Central California CHRIS Information Center[5]										
	○ Madera County: Southern San Joaquin Valley CHRIS Information Center[5]										
	○ Mariposa County: Central California CHRIS Information Center[5]										
	○ Merced County: Central California CHRIS Information Center[5]										
	○ San Joaquin County: Central California CHRIS Information Center[5]										
	○ Stanislaus County: Central California CHRIS Information Center[5]										
	○ Tuolumne County: Central California CHRIS Information Center[5]										
	- Implement the recommendations provided by the CHRIS information center(s) in response to the records search request.[5]										
	- Where adverse effects on cultural resources cannot be avoided, undertake additional CEQA review and develop appropriate mitigation to avoid or minimize the potential impact(s).[5]										
	- Require a professional trained to identify evidence of cultural resources to observe major excavation and earth-moving activities if significant cultural resources are known to exist on the project site or if there is a high probability for significant cultural resources to exist.[2]	—	—	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Construction will stop within a 100-foot radius of any archaeological, paleontological, or historical resources discovered during construction activities, and treatment measures will be devised as needed. A qualified archaeologist should be brought on site within 24 hours of the discovery. If the find is determined to be significant, a full archaeological survey will take place. Construction activities in the area resume once the survey is completed and all cultural resources are recovered.[2, 6]	—	—	X	X	X	X	X	X	X	X
	• No further excavation or other site disturbance takes place if any human remains are discovered during construction activities. Notify the local coroner so that a determination can be made as to whether the remains are of Native American origin or whether an investigation into the cause of death is required. If the remains are determined to be Native American, the following actions would be taken. ○ The coroner notifies the NAHC within 24 hours. ○ The NAHC immediately notifies those persons believed to be the most likely descendant(s) (MLD) of the deceased. ○ Once the NAHC identifies the MLD, the MLD, with the permission of the landowner, inspects the site of the discovery and makes recommendations for the treatment or disposition of the remains and any associated grave items within 48 hours (per Assembly Bill 2641) of the MLD being granted access to the site. ○ The landowner is to ensure that the immediate vicinity of the remains, established according to standard professional practices, is not damaged or disturbed by further activity until the landowner has conferred with the MLD. ○ Discussion and consultation between the landowner and MLD should take into account the possibility of multiple burials and reasonable options regarding the MLD's preferences for treatment. ○ If the NAHC is unable to identify an MLD, if the MLD fails to make a recommendation, or if the NAHC is unable to mediate a dispute concerning the appropriate disposition of the remains, the landowner shall re-inter the human remains and any associated items with appropriate dignity on the property in a location not subject to further subsurface disturbance; and, to protect the remains from disturbance, the landowner must record the site with the NAHC or the appropriate CHRIS, use an open space or conservation zoning designation or easement, and/or record a document with the county in which the property is located.[2,5]	X	—	X	X	X	X	X	X	X	X
	• No further disturbance of an area, if fossils are encountered, will occur until the materials have been evaluated by a qualified paleontologist and appropriate treatment measures have been identified.[4]	—	—	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Construction workers should be aware of the following protocols for identifying cultural resources: ○ If built environment resources or archaeological resources, including chipped stone (often obsidian, basalt, or chert), ground stone (often in the form of a bowl mortar or pestle), stone tools (such as projectile points or scrapers), unusual amounts of shell or bone, historic debris (such as concentrations of cans or bottles), building foundations, or structures are inadvertently discovered during ground-disturbing activities, the land owner should stop work in the vicinity of the find and retain a qualified cultural resources specialist to assess the significance of the resources. If necessary, the cultural resource specialist also will develop appropriate treatment measures for the find. ○ If human bone is found as a result of ground disturbance, the land owner should notify the county coroner in accordance with the instructions described above. If Native American remains are identified and descendants are found, the descendants may—with the permission of the owner of the land or his or her authorized representative—inspect the site of the discovery of the Native American remains. The descendants may recommend to the owner or the person responsible for the excavation work means for treating or disposing of the human remains and any associated grave goods, with appropriate dignity. The descendants will make their recommendation within 48 hours of inspection of the remains. If the NAHC is unable to identify a descendant, if the descendants identified fail to make a recommendation, or if the landowner rejects the recommendation of the descendants, the landowner will inter the human remains and associated grave goods with appropriate dignity on the property in a location not subject to further and future subsurface disturbance.[5]	—	—	X	—	X	X	X	X	X	X
	• Develop a cultural resources monitoring and mitigation plan for cultural resources (historical, archaeological, paleontological) newly discovered during reservoir drawdown periods.	—	—	—	—	X	—	—	—	—	—
Geology and Soils	• Require a licensed geologist to evaluate county general plans and other available geologic literature for additional geological information, and conduct site-specific geologic, geotechnical, and soil investigations to evaluate the potential for the presence of an active fault or other seismic risks (strong ground shaking, liquefaction, landslides, mass wasting, or other ground failure) for site-specific projects. [2]	—	—	X	X	X	X	—	X	X	X
	• Comply with existing local, state, and federal geotechnical regulations, building codes, standards specifications, and the recommendations of geotechnical studies prepared for site-specific projects.[2, 4]	—	—	X	X	X	X	—	X	X	X

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	• Evaluate the project site, and up- and down-gradient areas, for erosion potential. Design the project and implement construction and maintenance activities to prevent erosion and sedimentation.[2]	—	—	X	X	X	X	—	X	X	X
	• Design storm water runoff control systems to fit the hydrology of the project area once it is fully developed, to have adequate capacity to transport the flow from all upland/upstream areas, to be non-erosive, and to conduct runoff to a stable outlet. Install systems prior to the rainy season.[2]	—	—	X	X	X	X	—	X	X	X
	• Remove vegetation only when necessary and make every effort to conserve topsoil for reuse in revegetation of disturbed areas.[2]	—	—	X	—	X	X	—	X	X	X
	• Develop land in increments of workable size such that construction can be completed during a single construction season, and coordinate erosion and sediment control measures with the sequence of grading and construction operations.[2]	—	—	X	—	X	X	—	X	X	X
	• Stabilize and revegetate all disturbed soil surfaces before the rainy season.[2]	—	—	X	—	X	X	—	X	X	X
	• Restrict stockpiling of construction materials to the designated construction staging areas and exclusive of habitats and their buffer zones.[2]	—	—	X	—	X	X	—	X	X	X
	• Employ BMPs that prevent soil or sediment from leaving construction sites, monitor them for effectiveness, and maintain them throughout the construction operations and between construction seasons. Standard measures include installation of sediment basins and traps in conjunction with grading operations; development of slope drains; stabilization of stream banks; use of hydraulic mulch, hydroseeding, straw, mulch anchored with a tackifier, polyacrylamide, rolled erosion control products (e.g., blankets and mats), earth dikes, drainage swales, and velocity dissipation devices; and installation of silt fences, fiber rolls, gravel bag berms, sandbag barriers, storm drain inlet protection, and check dams.[2]	X	—	X	—	X	X	X	X	X	X
	• Contain runoff from truck and cement equipment washdown.[2]	—	—	X	—	X	X	—	X	X	X
	• Limit to the dry season any construction activities within an area of the Ordinary High Water (OHW) line of drainages and lakes. Limit any construction activities within a floodplain, but above an OHW line, to those actions that can adequately withstand high river flows without resulting in the inundation of and entrainment of materials in flood flows.[2]	—	—	X	—	X	X	—	X	X	X
	• Have a professional hydrologist or licensed engineer develop an erosion control and water quality protection plan to avoid habitat degradation and ensure compliance with local and state erosion- and sediment-related requirements. The plan should be integrated into the construction schedule and describe how site cleanup and regrading will affect current physical conditions.[2]	—	—	X	—	X	X	—	X	X	X
	• Locate projects away from areas with unsuitable soils or steep slopes.[2]	—	—	X	X	X	X	—	X	X	X

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	• Depending on soil and geologic conditions, do the following. ○ Ground improvements, such as soil compaction and excavation and disposal of liquefiable soils. ○ Structural improvements, such as berms or dikes, to prevent large lateral spreading. ○ Buttress landslides. ○ Install special drainage devices and water injection wells. ○ Monitor groundwater level to ensure stable conditions.[2]	—	—	X	X	X	X	—	X	X	X
	• Comply with all provisions of the applicable codes for the county or counties in which construction of a septic system is proposed, including the design and installation of septic systems. The design of those systems will be required in accordance with applicable county code to comply with all design requirements, including for factors such as wastewater generation, soil types within the leach field, percolation testing, and slope of the leach field.	—	—	—	—	X	—	—	—	—	—
Greenhouse Gas Emissions	• Implement all requirements under Air Quality, above.	X	—	X	X	X	X	X	X	X	X
	• Implement water recycling practices or policies.[2]	—	—	X	—	X	—	—	—	—	—
	• Preserve known GHG sinks to the extent feasible and limit GHG sources as a component of project design.[2]	—	—	—	—	X	—	—	—	X	—
	• Preserve or replace onsite trees or contribute to a mitigation program providing carbon storage.[2]	—	—	—	—	X	—	—	—	X	—
Hazards and Hazardous Materials	• Provide hazardous materials and worksite safety training for construction workers in accordance with local, state, and federal requirements including, but not limited to the Occupational Safety and Health Act, Title 9 of the Code of Federal Regulations, and Title 8 of the California Code of Regulations.[2]	X	—	X	X	X	X	X	X	X	X
	• Provide hazardous materials accidental spill response plans (and/or Hazardous Materials Management Program) and training that would outline methods, materials, and responsibilities for the response to, and clean-up of, an accidental hazardous material spill during construction of the project. At a minimum, the plans should include provisions for immediate response, containment, and cleanup of a spill, including excavation and disposal of contaminated soil and notification responsibilities. Materials needed for potential cleanup activities should be kept onsite.[2]	X	—	X	X	X	X	X	X	X	X
	• Provide a health and safety plan for construction workers that is prepared by a certified industrial hygienist; comply with all appropriate local, state, and federal regulations; and identifies specific safety measures to be followed during all phases of construction and long-term operation.[2]	X	—	X	X	X	X	X	X	X	X

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	• Conduct careful surveys of mine sites and prepare written reports and guidance in compliance with applicable state and federal requirements before commencing cleanup actions to identify and characterize safety concerns; potential for erosion during and after cleanup actions; potentially recyclable materials (e.g., sediment/soil for fill, scrap steel, processing equipment, brick, wood, mercury, and gold); and major waste streams for disposal in onsite or offsite landfills.[2]	X	—	—	—	X	X	X	X	X	—
	• Implement dust-suppression and other measures available to prevent risks associated with inhaling dust and exhaust during construction activities.[2]	X	—	X	X	X	X	X	X	X	X
	• Label all hazardous materials onsite to inform users of potential risks and train users in appropriate handling, storage, and disposal procedures.[2]	X	—	X	X	X	X	X	X	X	X
	• Protect sites from unmonitored access with fencing and signs to prevent accidental health hazards to the nearby residents.[2]	X	—	X	—	X	X	X	X	X	X
	• To control vector (e.g., mosquito) production, design projects so they do not increase the area and/or duration of standing water, selectively install systems that are prone to standing water away from high-density areas and away from residential housing, and/or incorporate measures to mitigate vector creation (e.g., install netting over devices and/or employ vector control agencies to mitigate vector production). Design projects to comply with local vector/mosquito control agencies' requirements.[2]	—	—	—	—	X	—	—	—	X	X
	• Adhere to applicable building and safety codes and permits that would ensure construction activities would result in less-than-significant delays in response times for fire and police vehicles.[2]	—	—	X	X	X	X	X	X	—	X
	• Coordinate with local fire and police providers to establish alternative routes and traffic control during the construction activities that could cause traffic congestion or road closures.[2]	—	—	X	X	X	X	X	X	—	X
	• Review California Department of Fire's Fire Hazard Safety Zone maps, contact local fire protection agencies during early phases of project planning and, if possible, select project sites that are not in High or Very High fire severity hazard zones.[2]	—	—	X	—	X	X	X	—	—	X
	• Identify local laws, ordinances, and building codes related to fire prevention, burning, welding, and blasting, etc., to obtain any necessary permits and adhere to permit conditions.[2]	—	—	X	X	X	X	X	X	X	X
	• Maintain an adequate number of fire extinguishers and other tools and equipment that can be used for fighting fire onsite, and ensure that personnel are trained in their use.[2]	—	—	X	—	X	X	X	X	X	X
	• Maintain a water tender during extensive welding/cutting operations.[2]	—	—	X	—	X	X	X	X	X	X
	• Maintain a fire watch during hazardous operations and after the work has ceased for the day.[2]	—	—	X	—	X	—	—	—	—	—
	• Provide funding for an inspector from the local fire agency.[2]	—	—	X	—	X	—	—	—	—	—
	• Provide equipment that gives construction personnel and fire agencies the ability to communicate with one another.[2]	—	—	X	—	X	X	X	X	X	X

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	• Remove materials that easily ignite or contribute to an increased intensity and spread of fire from high risk areas.[2]	—	—	X	—	X	X	X	X	X	X
	• Prepare and implement an RMP for the use and storage of anhydrous ammonia that meets the requirements of California Health and Safety Code, Division 20, Chapter 6.95, Article 2 and the California Code of Regulation Title 19, Division 2, Chapter 4.5, Articles 1–11. Submit the RPM to the appropriate local or regional agency for review and approval (e.g., San Joaquin County Environmental Compliance Division).[4]	X	—	X	—	X	X	—	X	—	—
	• Identify existing underground utility lines at excavation sites prior to construction, and avoid/relocate underground utility lines in coordination with utility company/service provider; coordinate with natural gas companies and Underground Service Alert before beginning any excavation or other construction activities to ensure that pipelines are not affected.[2,6]	—	—	X	X	X	X	X	X	X	X
	• Prior to construction, perform pre-construction hazardous waste evaluations through record searches and on-site evaluations to potentially identify leaking underground storage tanks, facilities that have received CDOs or CAOs for hazardous materials, or where soil contamination may be suspected (e.g., through soil discoloration or other indicators). If soil contamination is identified, test soil prior to excavation to determine if construction site would be located in area with soil contamination. Areas to be excavated will undergo soil and/or groundwater testing (if groundwater is present in excavated area) at a certified laboratory, provided existing data cannot characterize the nature and concentration of the contamination. Where concentrations exceed applicable federal or state thresholds, contaminated areas will be avoided or soil and/or groundwater will be remediated and contained in compliance with applicable state and federal laws. If hazardous materials are encountered, consultation with DTSC will be required to establish if a permit and subsequent actions are needed to appropriately handle the materials.	X	—	X	X	X	X	X	—	—	—
Hydrology and Water Quality	• Evaluate site-specific tsunami and seiche risks, comply with local building codes that address tsunami and seiche risk, and consult with an engineer to ensure that critical structures are designed to resist strong ground motion, tsunami, and seiche wave impact if appropriate for the project site.[2]	—	—	—	—	X	—	X	X	—	X
	• Elevate and brace any project buildings if buildings are located in areas prone to flooding or tsunamis.[2]	—	—	X	X	X	X	X	X	—	X
	• Position project roads and structures to be perpendicular to potential waves so there is less resistance and erosive force.[2]	—	—	X	—	X	—	—	X	—	—
	• Ensure that project activities do not weaken nearby levees.[2]	—	—	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Prepare a SWPPP that includes specific types and sources of storm water pollutants, determines the location and nature of potential impacts, and specifies appropriate control measures to eliminate any potentially significant impacts from storm water runoff on receiving waters. The SWPPP will require treatment BMPs that incorporate, at a minimum, the required hydraulic sizing design criteria for volume and flow to treat projected storm water runoff. The SWPPP shall comply with the most current standards established by the regional water quality control board. BMPs shall be selected from the local agency's Storm water Quality Control Standards.[4,6]	X	—	X	X	X	X	X	X	X	X
	• Implement turbidity monitoring during construction/removal.[6]	—	—	X	X	X	X	X	X	X	X
	• Comply with all provisions of the applicable codes for the county or counties in which construction of a septic system is proposed, including the design and installation of septic systems. The design of those systems will be required in accordance with applicable county code to comply with all design requirements, including for factors such as wastewater generation, soil types within the leach field, percolation testing, and slope of the leach field.	—	—	—	—	X	—	—	—	—	—
Land Use	• Comply with adopted plans, policies, and regulations.	X	—	—	X	X	X	X	X	X	X
	• All actions a lead agency determines is a covered action under the Delta Plan will comply with the Delta Plan Mitigation Monitoring and Reporting Program.	—	—	—	X	—	—	X	X	X	X
	• Locate facilities consistent with land use and zoning designations.	—	—	—	X	X	X	X	X	X	X
Mineral Resources	• Design new surface water facilities to avoid displacement of active natural gas wells to the extent feasible.	—	—	—	—	X	—	—	—	—	—
	• Design new surface water facilities to maintain drilling access to natural gas fields to the extent feasible.	—	—	—	—	X	—	—	—	—	—
	• Purchase affected aggregate resource sites.	—	—	—	—	X	—	—	—	—	—
Noise	• Limit construction work to the appropriate windows of construction per the local or regional noise ordinances. Typically construction is limited to 7:00 am–6:00 pm on weekdays and permit no work on Saturdays, Sundays, or holidays unless appropriate city and county building officials grant prior approval.[2, 3]	X	—	X	X	X	X	X	X	X	X
	• Implement noise-reducing construction practices such that noise from construction does not exceed applicable local noise standards or limits specified in the applicable county ordinances and general plan noise elements.[5,6]	X	—	X	X	X	X	X	X	X	X
	• Use noise-generating equipment during periods when fewer people are present near the construction area.[2]	X	—	X	X	X	X	X	X	X	X
	• Muffle or otherwise control all construction equipment with a high noise-generating potential, including all equipment powered by internal combustion engines.[2]	X	—	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Use newer equipment with improved noise muffling, and ensure that all equipment items have the manufacturers' recommended noise abatement measures, such as mufflers, engine covers, and engine vibration isolators, intact and operational. Newer equipment will generally be quieter in operation than older equipment. All installation equipment should be inspected at periodic intervals to ensure proper maintenance and presence of noise control devices (e.g., mufflers and shrouding).[3]	X	—	X	X	X	X	X	X	X	X
	• Shroud or shield all impact tools.[2]	X	—	X	X	X	X	X	X	X	X
	• Locate all stationary noise-generating equipment, such as compressors, as far as possible from adjacent occupied offices, residents, or sensitive habitats (if they are adjacent to the project site).[2]	X	—	X	X	X	X	X	X	X	X
	• Turn off mobile equipment and machinery when not in use to reduce noise from idling equipment.[2]	X	—	X	X	X	X	X	X	X	X
	• Use temporary noise barriers or curtains along installation boundaries or partial enclosures around continuously operating equipment.[2]	X	—	X	X	X	X	X	X	X	X
	• Use the shortest possible routes from construction sites to local freeways for truck delivery routes, except when selecting routes to avoid going through residential neighborhoods.[2]	X	—	X	X	X	X	X	X	X	X
	• Establish an active community liaison program that notifies landowners within 300 ft of construction areas of the construction schedule, in writing, prior to construction to keep them informed of schedule changes, and designate a “disturbance coordinator” for the construction site.[2]	X	—	X	X	X	X	X	X	X	X
	• Develop an operations plan for specific construction activities that documents maximum noise limits and addresses the variety of available measures to limit the impacts from noise on adjacent homes, businesses, or sensitive habitats.[2]	X	—	X	X	X	X	X	X	X	X
	• Regularly inspect equipment and monitor noise and vibration to ensure that all equipment on the site is in good condition and effectively muffled and that contractors take all reasonable steps to minimize impacts, particularly when near sensitive areas.[2, 3]	X	—	X	X	X	X	X	X	X	X
	• Monitor construction noise and vibrations and modify and/or reschedule construction activities if monitoring determines that maximum limits set by local or regional noise ordinances are exceeded.[2,3]	X	—	X	X	X	X	X	X	X	X
Population and Housing	• Planned growth would be subject to growth management provisions of applicable general plans.	—	—	—	X	X	—	—	—	—	—
Public Services	• Notify local emergency and police service providers of construction activities and road closures, if any, and coordinate with the local police protection to establish alternative routes and traffic control during the installation activities.[3]	—	—	X	X	X	X	X	X	—	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
Transportation and Traffic	• Use signage, striping, fencing, barricades, and other physical structures to mark the excavated areas, promote safety, and minimize pedestrian/bicyclist accidents.[2]	X	—	X	X	X	X	X	X	—	X
	• Control traffic with signals or traffic control personnel in compliance with authorized local police or California Highway Patrol requirements.[2]	X	—	X	X	X	X	X	X	—	X
	• Develop and implement a project-specific construction traffic management plan to minimize traffic impacts on the local circulation system and ensure that construction activities adhere to local and state police and transportation requirements. A construction traffic management plan could address traffic control for any street closure, detour, or other disruption to traffic circulation; identify the routes that construction vehicles will use to access the site, hours of construction traffic, and traffic controls and detours; and include strategies for temporary traffic control, temporary signage and tripping, location points for ingestion and egress of construction vehicles, staging areas, and timing of construction activity that appropriately limits hours during which large construction equipment may be brought on or offsite and identify the need for and use of signage, striping, fencing, barricades, and other physical structures to mark minimize pedestrian/bicyclist accidents and identify public transit closures, or relocations, if needed.[2]	X	—	X	X	X	X	X	X	—	X
	• Restore public transit facilities, bicycle lanes, or pedestrian facilities (e.g., sidewalks) if closed, damaged or moved during construction, prior to the completion of construction of the entire project.	X	—	X	X	X	X	X	X	—	X
	• Limit or restrict hours of construction so as to avoid peak traffic times.[2]	X	—	X	X	X	X	X	X	—	X
Utilities and Service Systems	• Coordinate power outages and notify potentially affected utility users of temporary loss of electricity.[6]	—	—	X	X	X	X	X	X	—	X
	• Existing underground utility lines at excavation sites will be identified prior to construction and underground utility lines will be avoided or relocated in coordination with the utility company or service provider.[6]	—	—	X	X	X	X	X	X	—	X
	• Comply with all provisions of the applicable codes for the county or counties in which construction of a septic system is proposed, including the design and installation of septic systems. The design of those systems will be required in accordance with applicable county code to comply with all design requirements, including for factors such as wastewater generation, soil types within the leach field, percolation testing, and slope of the leach field.	—	—	—	—	X	—	—	—	—	—

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
Operation											
Aesthetics	• Direct operational lighting away from any residential and roadway areas.[2]	X	—	—	X	X	X	X	X	—	X
	• Develop and implement a lighting plan to comply with local jurisdiction lighting requirements that may exist. The lighting plan could include stipulations such as the following. ○ Design site lighting and exterior building light fixtures to reduce the effects of light pollution and glare off of glass and metal surfaces. ○ Lighting shall be directed downward and light fixtures shall be shielded to reduce upward and spillover lighting. ○ Where it is not feasible to fully shield light fixtures from emitting light pollution, the lighting shall be directed downward and be of the minimum wattage and height suitable for illuminating the areas to be secured and the exterior work areas for worker safety.[4]	X	—	—	X	X	X	X	X	—	X
	• Apply minimum lighting standards. [6]	—	—	—	X	X	X	X	X	—	X
	• Use landscape vegetation to buffer views of new facilities if sensitive receptors are present and reduce visibility of new structures.[2,6]	X	—	X	X	X	X	X	X	—	X
	• Use building materials that do not create a source of glare if sensitive receptors are present.[2,6]	X	—	X	X	X	X	X	X	—	X
Agriculture and Forestry Resources	• Treat used municipal water and return it to the senior water right holder as recycled water for agricultural uses.	—	—	—	—	X	—	—	—	—	—
Air Quality	• Apply appropriate mitigation measures from the applicable air district to reduce operational emissions. These measures are suggested by the district or are documented in official rules and guidance reports; however, not all districts make recommendations for operational mitigation measures. Where applicable, measures will be applied on a project-level basis and may be tailored in consultation with the appropriate air district, depending on the severity of anticipated operational emissions.[5]	—	—	X	X	X	X	X	X	—	X
	• Apply appropriate TAC and HAP mitigation measures from the applicable air district to reduce public exposure to DPM, pesticides, and asbestos. These measures are suggested by the district or are documented in official rules and guidance reports; however, not all districts make recommendations for mitigation measures for TAC/HAP emissions. These measures will be applied on a project-level basis and may be tailored in consultation with the appropriate air district, depending on the severity of anticipated TAC/HAP emissions.[5]	—	—	X	X	X	X	X	X	—	X
	• Perform necessary equipment maintenance, such as inspections and corrections, to detect failures early so that the equipment operates cleanly and efficiently.[2]	X	—	X	—	X	X	X	X	—	—
	• Use maintenance vehicles with zero-emission or lower-emission engines.[2]	—	—	X	—	X	X	X	X	—	—

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Limit the unnecessary idling of delivery vehicles and equipment.[2]	—	—	X	—	X	X	X	X	—	—
	• Use low/zero carbon fuels, such as B20 biodiesel or renewable diesel.[2]	—	—	X	—	X	X	X	X	—	—
	• Install diesel particulate filter and utilize diesel oxidation catalyst.[6]	—	—	—	—	X	—	—	—	—	X
	• Require the pump system be electric or alternatively fueled.[6]	—	—	—	—	X	—	—	—	—	X
Biological Resources	• During maintenance activities, properly contain or remove all trash that may attract predators to the worksite. [2]	—	—	X	X	X	X	—	—	—	X
Geology and Soils	• Comply with all provisions of the applicable codes for the county or counties in which operation of a septic system is proposed, including the design and installation of septic systems. The design of those systems will be required in accordance with applicable county code to comply with all design requirements, including for factors such as wastewater generation, soil types within the leach field, percolation testing, and slope of the leach field.	—	—	—	—	X	—	—	—	—	—
Greenhouse Gas Emissions	• See measures in Air Quality, above.	X	—	X	X	X	X	X	X	—	X
	• Perform necessary equipment maintenance, such as inspections and corrections, to detect failures early so that the equipment operates cleanly and efficiently.[2]	X	—	X	X	X	X	X	X	—	X
	• Implement water recycling practices or policies.[2]	—	—	X	—	X	—	—	X	—	—
	• The California Attorney General's office report entitled, *Addressing Global Warming at the Local Agency Level*, identifies various example measures to reduce GHG emissions at the project level (California Department of Justice 2008). The following mitigation measures and project design features were compiled from the California Attorney General's Office report. These measures are not meant to be exhaustive but to provide a sample list of measures that could be incorporated into future project design. The solid waste measures and transportation measures are listed below. ○ Reuse and recycle construction and demolition waste (including, but not limited to, soil, vegetation, concrete, lumber, metal, and cardboard). ○ Provide interior and exterior storage areas for recyclables and green waste and adequate recycling containers. ○ Recover byproduct methane to generate electricity. ○ Limit idling time for commercial vehicles, including delivery and construction vehicles. ○ Use low- or zero-emission vehicles, including construction vehicles.[5]	—	—	X	X	X	X	X	X	—	X
	• Require pump system to be electric.[6]	X	—	—	—	X	—	—	—	—	X

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
Hazards and Hazardous Materials	• Provide hazardous materials and worksite safety training for workers who maintain the projects in accordance with local, state, and federal requirements, such as the Occupational Safety and Health Act, Title 9 of the Code of Federal Regulations, and Title 8 of the California Code of Regulations.[2]	X	—	X	—	X	—	X	X	—	—
	• Provide hazardous materials accidental spill response plans (and/or Hazardous Materials Management Program) and training that would outline methods, materials, and responsibilities for the response to, and clean-up of, an accidental hazardous material spill during long-term maintenance of the project. At a minimum, the plans should include provisions for immediate response, containment, and cleanup of a spill, including excavation and disposal of contaminated soil and notification responsibilities. Materials needed for potential clean-up activities should be kept onsite.[2,6]	X	—	X	X	X	—	X	X	—	X
	• Provide a health and safety plan for maintenance workers that is prepared by a certified industrial hygienist; complies with all appropriate local, state, and federal regulations; and identifies specific safety measures to be followed during long-term operation.[2]	X	—	X	X	X	—	X	X	—	X
	• Label all hazardous materials onsite to inform users of potential risks, and train users in appropriate handling, storage, and disposal procedures.[2]	X	—	X	X	X	—	X	X	—	X
	• Maintain an adequate number of fire extinguishers and other tools and equipment that can be used for fighting fire onsite, and ensure that personnel are trained in their use.[2]	X	—	X	X	X	—	X	X	—	X
	• Provide equipment that provides operations personnel and fire agencies the ability to communicate with one another.[2]	X	—	X	X	X	—	X	X	—	X
	• Maintain a defensible space around the perimeter of the project area.[2]	—	—	X	X	X	—	X	X	—	X
	• Implement dust-suppression and other measures available to prevent risks associated with inhaling dust and exhaust during maintenance activities.[2]	X	—	X	—	X	—	—	X	—	—
	• Dewater and dispose of waste brine at an appropriate landfill. If suitable, and depending on the volumes and characterization of the brine, use the brine byproduct in a solar-thermal electrical generation process to help offset electrical costs to run a desalination device.	—	—	—	—	X	—	X	X	—	—
Hydrology and Water Quality	• Actively educate project personnel about tsunami and seiche hazards, characteristics, and evacuation routes as part of site safety training.[2]	—	—	—	—	X	—	—	—	—	—
	• Develop multiple ways to receive tsunami and seiche warnings and alert site personnel.[2]	—	—	—	—	X	—	—	—	—	—
	• Develop a formal tsunami hazard plan as part of the project's site safety plan, and conduct emergency exercises.[2]	—	—	—	—	X	—	—	—	—	—

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Comply with all provisions of the applicable codes for the county or counties in which operation of a septic system is proposed, including the design and installation of septic systems. The design of those systems will be required in accordance with applicable county code to comply with all design requirements, including for factors such as wastewater generation, soil types within the leach field, percolation testing, and slope of the leach field.	—	—	—	—	X	—	—	—	—	—
Noise	• Employ noise-reducing operational measures; develop plans for operations and maintenance activities to address the variety of available measures to limit the impacts from noise on adjacent homes, businesses, or sensitive habitats.[2, 6]	X	—	X	—	X	X	—	X	—	X
	• Ensure all noise producing equipment under operating conditions (e.g., pumps) are enclosed or located behind barriers such that noise does not exceed applicable local noise standards or limits specified in the applicable county ordinances and general plan noise elements if sensitive receptors are present.[5]	X	—	X	X	X	X	—	X	—	X
Public Services	• Coordinate reservoir and associated recreational plans with local towns, counties, Sheriff's Department, Highway Patrol, CALFIRE, and other agencies to identify needed permit and regulatory oversight, police and fire protection and other public services for both construction and operations.	—	—	—	—	X	—	—	—	—	—
	• Coordinate reservoir development and operation plans (including associated recreation sites) with local, county, and state agencies to identify funding sources needed for increased personnel, equipment, and facilities.	—	—	—	—	X	—	—	—	—	—
Transportation and Traffic	• Follow SJCOG Regional Congestion Management Program (RCMP) policy regarding mitigation measures for capital improvement projects, which includes: mitigation measures must be adequate to allow RCMP roadway to meet RCMP LOS Standard; mitigation measures must be fully funded to be considered adequate; mitigation measures that rely on state or federal funds directed by or influenced by SJCOG must be consistent with project funding priorities established in the capital improvement plan of the RCMP and RTP or Federal TIP; and, for those mitigation measures that involve fair share contributing for mitigating cumulative impacts, the fee must be committed to funding priorities established in the capital improvement plan of the RCM, the RTP, or the Federal TIP.[8]	—	—	—	—	—	X	X	X	—	—
	• Prepare cumulative impacts on the RCMP network and reflect the most recently approved development projects from the lead agency as well as from adjacent jurisdictions (including currently programmed infrastructure improvements). [8]	—	—	—	—	—	X	X	X	X	—
	• If an RCMP intersection is projected to operate at LOS E or F after trip exemptions have been accounted for, the affected jurisdiction can choose to proactively prepare a deficiency plan in lieu of waiting for the facility to possibly fail after the development is implemented.[8]	—	—	—	—	—	X	X	X	X	—

Resource	Potential Mitigation Measure	Substituting Surface Water with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources	In-Delta Diversion	New Surface Water Storage	New Source Water Supplies	Salinity Pretreatment Programs	Wastewater Treatment Plant Desalinization	Agricultural Return Flow Salinity Control	Low Lift Pump Station(s)
	• Follow the SJCOG RCMP specific mitigation fee program relative to cumulative regional impacts, if applicable, and track actual funding/implementation.[8]	—	—	—	—	—	X	X	X	X	—
Utilities and Service Systems	• Comply with all provisions of the applicable codes for the county or counties in which operation of a septic system is proposed, including the design and installation of septic systems. The design of those systems will be required in accordance with applicable county code to comply with all design requirements, including for factors such as wastewater generation, soil types within the leach field, percolation testing, and slope of the leach field.	—	—	—	—	X	—	—	—	—	—

Sources: [1]North Coast Regional Water Quality Control Board 2009, [2]Central Valley Water Board 2010a, [3]California Regional Water Quality Control Board, Los Angeles Region 2011, [4]City of Tracy 2011, [5]Central Valley Water Board 2010b, [6]DWR 2011c, [7]SFPUC 2007, [8]SJCOG 2016b, [9]CALFED 2000b.

Notes:

[a] Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts would be mitigated to less than significant once mitigation measures were implemented.

[b] Potential mitigation measures for conflicts with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations protecting biological species and resources that maybe attributable to land use and planning are presented in the Biological Resources sections in this table.

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16.6.2 Non-Flow Measures

The regulated public agencies would likely be required to comply with CEQA and perform a project-specific analysis, and engineering design should they determine the need, to approve a discretionary action associated with a non-flow measure. The project-specific analysis would be required to identify potentially significant environmental impacts. The lead agency would be required to require the implementation of all feasible mitigation measures to reduce impacts to less than significant or be responsible for providing a statement of overriding considerations for significant impacts that cannot be mitigated to a level of less than significant. Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, identifies the potential mitigation measures that the regulated community could implement should they determine a discretionary action they approve has significant impacts. These mitigation measures are based, in part, on mitigation measures presented in the following documents.

- *Proposed Amendment to the Water Quality Control Plan for the North Coast Region to Establish Exception Criteria to Point Source Waste Discharge Prohibition by Raising the Action Plan for Storm Water Discharges and Adding a New Action Plan for Low Threat Discharges* (North Coast Regional Water Quality Control Board 2009).
- *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento and San Joaquin Delta Estuary* (Central Valley Water Board 2010a).
- *Substitute Environmental Document for Toxic Pollutants in the Dominguez Chanel and Greater Los Angeles and Long Beach Waters Total Maximum Daily Load* (California Regional Water Quality Control Board, Los Angeles Region 2011).
- *Initial Study and Mitigated Negative Declaration for the Tracy Desalination and Green Energy Project* (City of Tracy 2011).
- *Irrigated Lands Regulatory Program Environmental Impact Report* (Central Valley Water Board 2010b).
- Low Head Pump Salinity Control Study Prepared to Meet Requirements of the State of California State Water Resources Control Board Water Rights Order WR 2010-0002, Condition A.7. Appendix C: Environmental Considerations for South Delta Low Head Pump Station (DWR 2011c).
- *Water Supply Options* (SFPUC 2007).
- *Biological Opinion for the 2014 Georgiana Slough Floating Fish Guidance Structure Study in Sacramento County* (NMFS 2014b).
- *Battle Creek Salmon and Steelhead Restoration Project. Environmental Implementation Plan* (ICF Jones & Stokes 2013).
- *Bay Delta Conservation Plan. Public Draft* (DWR 2013c).

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777, subd. (b)(d).) Feasible mitigation measures are intended to avoid, reduce, or compensate for adverse impacts on a resource and can include actions such as implementation of plans to minimize impacts. For each impact identified as significant, a mitigation measure to reduce that impact to a less-than-significant level is described, if appropriate, or the infeasibility of mitigation is discussed. One legal factor that may render a mitigation measure infeasible is the limited authority of the lead agency. CEQA does not grant agencies new, discretionary powers independent of the powers granted to the agencies by other laws. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040.) Accordingly, a mitigation measure may be legally infeasible if the lead agency does not have the discretionary authority to implement it. In addition, economic considerations may render mitigation measures infeasible. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, §§ 15040, 15041, 15126.4, 15364.) The authority to require project-level mitigation lies with the lead agencies undertaking or approving the individual projects, not the State Water Board. These agencies can and should impose the mitigation measures presented in Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*.

Table 16-39. Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures[a]

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
Construction									
Aesthetics	• Direct construction lighting away from residential and roadway areas if sensitive receptors are present.[2]	—	—	—	X	—	X	—	—
Agriculture and Forestry Resources	• Require payment of the appropriate Agricultural Mitigation Fee, as required by local agencies consistent with applicable law, to offset the loss of Prime and Unique Farmland if construction activities disturb or destroy Prime Farmland or Unique Farmland, as defined by the California Department of Conservation.[4]	X	—	—	—	—	—	—	—
	• Avoid agricultural lands (Prime Farmland, Unique Farmland, and Farmland of Statewide Importance) to the greatest extent possible.[6]	X	—	—	—	—	—	—	—
	• Restore existing degraded habitat as a priority before converting agricultural land (Prime Farmland, Unique Farmland, and Farmland of Statewide Importance). [10]	X	—	—	—	—	—	—	—
	• Site and align project features to avoid or minimize impacts on agriculture, particularly on Prime Farmland, Unique Farmland, and Farmland of Statewide Importance. [10]	X	—	—	—	—	—	—	—
	• Focus habitat restoration efforts on developing new habitat on public lands before converting agricultural land (Prime Farmland, Unique Farmland, and Farmland of Statewide Importance). [10]	X	—	—	—	—	—	—	—
	• If public lands are not available for restoration efforts, focus restoration efforts on acquiring lands that can meet ecosystem restoration goals from willing sellers where at least part of the reason to sell is an economic hardship (for example, lands that flood frequently or where levees are too expensive to maintain). [10]	X	—	—	—	—	—	—	—
	• Use farmer-initiated and developed restoration and conservation projects as a means of reaching project goals. [10]	X	—	—	—	—	—	—	—
	• Obtain easements on existing agricultural land for minor changes in agricultural practices (such as flooding rice fields after harvest) that would increase the value of the agricultural crop(s) to wildlife. [10]	X	—	—	—	—	—	—	—
	• Include provisions in floodplain restoration efforts for compatible agricultural practices. [10]	X	—	—	—	—	—	—	—
	• Use a planned or phased habitat development approach in concert with adaptive management. [10]	X	—	—	—	—	—	—	—
	• Minimize the amount of water supply required to sustain habitat restoration acreage. [10]	X	—	—	—	—	—	—	—
	• Implement features that are consistent with local and regional land use plans. [10]	X	—	—	—	—	—	—	—
	• Involve all affected parties, especially landowners and local communities, in developing appropriate configurations to achieve the optimal balance between resource impacts and benefits. [10]	X	—	—	—	—	—	—	—

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
Air Quality	• Apply appropriate construction mitigation measures from the applicable air district (e.g., SJVAPCD) to reduce construction emissions. These measures will be applied on a project-level basis and may be tailored in consultation with the appropriate air district, depending on the severity of anticipated construction emissions.[5]	X	X	X	X	X	X	X	X
	• Apply appropriate TAC and HAP mitigation measures from the applicable air district to reduce public exposure to DPM pesticides, and asbestos. These measures are documented in official rules and guidance reports; however, not all districts make recommendations for mitigation measures for TAC/HAP emissions. These measures will be applied on a project-level basis and may be tailored in consultation with the appropriate air district, depending on the severity of anticipated TAC/HAP emissions.[5]	X	X	X	X	X	X	X	X
	• Use vehicles with zero-emission or lower-emission engines.[2]	X	X	X	X	X	X	X	X
	• Limit the unnecessary idling of vehicles and equipment.[2]	X	X	X	X	X	X	X	X
	• Use low/zero carbon/alternative fuels, such as B20 biodiesel or renewable diesel.[2]	X	X	X	X	X	X	X	X
	• Control visible emissions from off-road diesel powered equipment.[2]	X	X	X	X	X	X	X	X
	• Design structural devices to minimize the frequency of maintenance trips.[2]	X	X	X	X	X	X	X	X
	• Perform necessary equipment maintenance, such as inspections and corrections, to detect failures early keep equipment operating cleanly and efficiently.[2]	X	X	X	X	X	X	X	X
	• Use the proper sized equipment for the job during construction and operation.[2]	X	X	X	X	X	X	X	X
	• Train equipment operators in proper use of equipment during construction and operation.[2]	X	X	X	X	X	X	X	X
	• Produce concrete onsite if determined to be less emissive than transporting ready mix.[2]	—	—	—	X	X	X	—	—
	• Use locally sourced or recycled materials for construction materials.[2]	—	—	—	X	X	X	—	—
	• Control fugitive dust emissions during land clearing, grubbing, scraping, excavation, leveling, grading, or cut and fill operations with application of water (at least twice daily) or by presoaking.[2,4]	X	X	X	X	X	X	X	X
	• Cover stockpiles of soil, sand, and other materials, and stabilize all disturbed areas and storage piles that are not being actively utilized for construction purposes using water, chemical stabilizers, or by covering with tarps, other suitable cover, or vegetative ground cover.[2,4]	X	X	X	X	X	X	X	X
	• Pave, apply water, or apply soil stabilizers to unpaved areas, including all access roads and parking areas.[2,4]	X	X	X	X	X	X	X	X
	• Sweep surrounding streets and paved areas (e.g., once per day).[2]	X	X	X	X	X	X	X	X
	• Suspend excavation and grading activity when winds (instantaneous gusts) exceed 25 miles per hour and/or greater than 20 miles per hour over a 1-hour period.[2,4]	X	X	X	X	X	X	X	X
	• Initiate landscaping and revegetation as soon as construction tasks allow in order to minimize wind erosion.[2]	X	X	X	X	X	X	X	—
	• Encourage ride sharing and of use transit transportation for construction employees commuting to the project site.[4]	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• Use electric equipment for construction whenever possible in lieu of fossil fuel-powered equipment.[4]	X	X	X	X	X	X	X	X
	• Discontinue all construction activities during first stage smog alerts, first stage ozone alerts, and/or curtail construction during periods of high ambient pollutant concentrations.[4]	X	X	X	X	X	X	X	X
	• Water previously disturbed exposed surfaces (soil) a minimum of 3 times per day or whenever visible dust is capable of drifting from the site or approaches 20 percent opacity.[4]	X	X	X	X	X	X	X	X
	• Water all haul roads (unpaved) a minimum of 3 times per day or whenever visible dust is capable of drifting from the site or approaches 20 percent opacity.[4]	X	X	X	X	X	X	X	X
	• Reduce speed on unpaved roads to less than 15 miles per hour.[4]	X	X	X	X	X	X	X	X
	• Install and maintain a trackout control device that meets the specifications of regional air board requirements if needed (e.g., SJVAPCD Rule 8041 if the site exceeds 150 vehicle trips per day or more than 20 vehicle trips per day by vehicles with three or more axles.[4]	X	X	X	X	X	X	X	X
	• Cover trucks hauling debris, soil, sand, or other material to reduce dust and suspended air particles, and when transporting materials offsite, maintain a freeboard limit of at least 6 inches or effectively wet to limit visible dust emissions.[4,2]	X	X	X	X	X	X	X	X
	• Limit and remove the accumulation of mud and/or dirt from adjacent public roadways at the end of each workday.[4]	X	X	X	X	X	X	X	X
	• Remove visible trackout from the site at the end of each workday.[4]	X	X	X	X	X	X	X	X
	• Comply with applicable regional air board asphalt-concrete paving rules such as SJVAPCD Rule 4641 (e.g., restrict use of cutback, slow-sure, and emulsified asphalt paving materials).[4]	X	X	X	X	X	X	X	X
	• Install diesel particulate filter and utilize diesel oxidation catalyst.[6]	X	X	X	X	X	X	X	X
	• Require the pump system be electric or alternatively fueled.[6]			X		X	X	X	
	• Locate pump system/emissions generating activity as far from sensitive receptors as possible.[6]	X	X	X	X	X	X	X	X
Biological Resources[b]	• Prior to land disturbance, contact USFWS and CDFW and conduct all necessary preconstruction surveys for special-status plants, species, and habitat prior to construction activities. This may include the hiring of a qualified biologist to identify riparian and other sensitive vegetation communities and/or habitat for special-status plants and animals.[1, 5,6]	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• Comply with local, state, and federal regulations and ordinances such as those listed below. ○ USFWS ESA Section 7 consultation for threatened and endangered species.[2] ○ U.S. Army Corps of Engineers Section Clean Water Act 404 Permit and State Clean Water Act Section 401 Water Quality Certification for filling or dredging waters of the United States and other federal permitting actions.[2, 5] ○ CDFW California Fish and Game Code Section 1601 Agreement for Streambed Alteration.[2] ○ State Water Board WDRs (which are also permits for purposes of the Clean Water Act, if applicable).[2] ○ General plan conservation requirements.[2]	X	X	X	X	X	X	X	X
	City and/or county tree ordinances.[2] • Contract with qualified botanists, wildlife biologists, and arborists to develop biological assessments if a project's specific location warrants doing so. At a minimum, assessments should include project area-specific literature searches, reviews of CDFW's California Natural Diversity Database and the California Native Plant Society's Inventory of Rare and Endangered Plants of California, and field surveys of all potential project sites and their surrounding areas to identify and map existing plant communities, wildlife habitat, and heritage trees, and to identify wildlife species that currently occur, have occurred in the past (e.g., resident and migratory wildlife species that have been documented as foraging or nesting at the site), or have the potential to occur at the site due to the presence of suitable habitat. Field surveys should follow protocols established by CDFW and should be conducted during the appropriate time(s) of year (e.g., during the blooming period of potentially occurring plant species).[2,5]	X	X	X	X	X	X	X	X
	• Avoid and minimize disturbance of riparian and other sensitive vegetation communities.[5]	X	X	X	X	X	X	X	X
	• Avoid and minimize disturbance of areas containing special-status plant or animal species.[5]	X	X	X	X	X	X	X	X
	• Where adverse effects on sensitive biological resources (including fish species) cannot be avoided, undertake additional CEQA review and develop a restoration or compensation plan to mitigate the loss of the resources.[5]	X	X	X	X	X	X	X	X
	• Where construction in areas that may contain special-status fish species cannot be avoided through the use of alternative management practices, conduct an assessment of habitat conditions and the potential for presence of special-status fish species prior to construction; this may include the hiring of a qualified fish biologist to determine the presence of special-status fish species.[5]	X	X	X	X	X	X	X	X
	• Based on the species present in adjacent waterbodies and the likely extent of construction work that may affect fish, limit construction to periods that avoid or minimize impacts on special-status fish species.[5]	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• If there is a possibility of fish stranding within cofferdams, a fish rescue plan will be written and submitted to the appropriate resource agencies (NMFS, CDFW). Some of the following actions may be included:[9] ○ Fish rescue operations will occur at any project site where dewatering and resulting isolation of fish may occur, e.g., when dewatering creates pools within the stream channel or when an enclosed area within a cofferdam is dewatered. ○ Collection of fish for rescue from areas isolated by dewatering may occur by electrofishing, netting (seining or dipnetting), or a combination of these. The appropriate collection method will be determined based on site conditions. ○ The fish rescue team will include at least one person with a 4-year college degree in fisheries or biology, or a related degree. The person also must have at least 2 years of professional experience in fisheries field surveys and the use of electrofishing equipment. ○ Transfer captured fish into 5-gallon buckets filled with clean, cold creek water, supplied either with an aerator to maintain an adequate dissolved oxygen concentration or multiple small holes to provide flow-through conditions when placed on the creek bed. ○ Note the date, time, and location of collection; species; number of fish; approximate age (e.g., young-of-the-year, yearling, adult); fish condition (dead, visibly injured, healthy); approximate water depth; and water temperature. ○ Release living anadromous salmonids downstream of the project area if it is determined that they are downstream migrants, noting release date, time, and location. ○ Place dead fish in sealed zip-lock bags on ice with labels indicating species, location, date, and time of collection, and store them on ice. ○ Freeze collected dead fish as soon as possible, provide the frozen specimens to the USFWS Office for tissue analysis and run determination (if possible), and retain specimens until NMFS advises on their disposition or until 6 months after capture.	—	—	X	—	X	X	—	—
	• Develop a mitigation and management plan in coordination with CDFW and USFWS to implement all appropriate measures as required by USFWS ESA Section 7 consultation and to satisfy any other local, state, and federal requirements for achieving no net loss of wetlands, riparian habitat or other critical habitat, or take of wildlife species of concern. The plan should be submitted to the local city/county environmental planning department, U.S. Army Corps of Engineers, USFWS, CDFW, applicable regional board (e.g., as part of a Clean Water Act Section 401 Water Quality Certification application), and/or other oversight agencies as applicable for approval prior to its implementation if an impact on special-status species population(s) is determined to occur based on the biological assessment and evaluation of the final project site and design.[2]	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• Develop a revegetation plan if vegetation would be disturbed during construction or operation. The re-vegetation plan should be prepared by a qualified restoration ecologist and reviewed by the appropriate agencies. The plan should specify sites where revegetation should take place, the planting stock appropriate for the region, appropriate designs (e.g., plant arrangements that, when mature, replicate the natural structure and species composition of similar habitats in the region), planting techniques, monitoring frequency, and success criteria (e.g., sapling trees no longer require active management).[2]	X	X	X	X	X	X	X	X
	• Establish temporary construction buffers for drainages, wetlands/vernal pools, and other sensitive habitat in the project area that could be affected by construction activities. The outer edges of the buffer zones will be demarcated using flagging or temporary orange mesh construction fencing before initiation of construction activities and based on site-specific conditions, seasonal restrictions for wildlife, local planning department specifications, and resource agency (e.g., USFWS and CDFW) requirements.[2,6]	X	X	X	X	X	X	X	X
	• Require a qualified biologist to perform the following construction functions if sensitive habitat or species are present. ○ Perform required preconstruction surveys to determine the current presence of, and demarcate the boundaries of construction buffers around, sensitive habitats, and submit survey reports according to CDFW and local agency guidelines for approval prior to construction.[1,2,5,6] ○ Provide USFWS-approved worker environmental awareness training that informs all construction personnel about sensitive plant and wildlife species and habitats.[2] ○ Oversee major excavation and other construction activities with the authority to stop construction activities until appropriate corrective measures have been completed.[2] ○ Report to USFWS any incidental take.[2] ○ Periodically re-inspect the project site (e.g., every week) during construction activities or whenever a there has been a substantial lapse in construction activity (e.g., more than 2 weeks).[2]	X	X	X	X	X	X	X	X
	• Locate temporary access roads and staging areas outside the boundaries of critical habitat areas, restrict movement of heavy equipment to and from the project site to established roadways and areas designated for construction and staging, and do not allow parking of vehicles or storage of potentially-toxic chemicals near or up-gradient of drainages or sensitive habitats or under heritage trees.[2]	X	X	X	X	X	X	X	X
	• Implement measures to control dust, erosion, and noise (see the Air Quality, and Geology and Soils, respectively).[2]	X	X	X	X	X	X	X	X
	• Properly contain or remove all trash that may attract predators to the worksite during construction.[2]	X	X	X	X	X	X	X	X
	• Remove any temporary fill and construction debris and, wherever feasible, restore disturbed areas to pre-project conditions according to the before-mentioned revegetation plan after completion of construction activities.[2]	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• Provide compensation for unavoidable degradation or loss of critical habitat due to project construction to ensure no net loss of that habitat as required by local, state, or federal agencies. Compensation could be provided at a minimum ratio (e.g., 3:1, 3 acres of restored wetlands for every 1 acre affected, or three native oak trees planted for every native oak tree eliminated) that ensures long-term replacement of habitat functions and values and complies with local, state, and federal requirements. Examples of compensation are as follows. ○ Construct replacement habitat as close as possible to the previous habitat location at the project site (e.g., locate replacement riparian and wetland habitats along the same drainage affected by the project construction). ○ If site limitations prevent onsite habitat replacement, construct replacement habitat as near the project site as possible.	X	X	X	X	X	X	X	X
	• Provide payment on a per-acre basis to an approved restoration or mitigation bank or other trust fund.[2]	X	X	X	X	X	X	X	X
	• Comply with measures contained within habitat conservation plans or natural community conservation plans, such as the San Joaquin Multi-Species Habitat Conservation and Open Space Plan. Consult with appropriate biologists who have training and are knowledgeable about the habitat conservation plan or natural community conservation plan. Monitoring, construction, and relocation surveys by a qualified biologist would be done as appropriate.[4]	X	X	X	X	X	X	X	X
	• Prior to implementing any management practice that would result in the permanent loss of wetlands, conduct a delineation of affected wetland areas to determine the acreage of loss in accordance with current U.S. Army Corps of Engineers methods. For compliance with the Clean Water Act Section 404 permit and WDRs, compensate for the permanent loss (fill) of wetlands and ensure no net loss of habitat functions and values. Compensation ratios will be determined through coordination with the Central Valley Water Board and U.S. Army Corps of Engineers as part of the permitting process. Compensation may be a combination of mitigation bank credits and restoration/creation of habitat, as described below. ○ Purchase credits for the affected wetland type (e.g., perennial marsh, seasonal wetland) at a locally approved mitigation bank and provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. ○ Develop and ensure implementation of a wetland restoration plan that involves creating or enhancing the affected wetland type.[5]	X	X	X	X	X	X	X	X
	• Install species exclusion fencing for animal species during construction; install a temporary, plastic mesh-type construction fences at least 1.2 m tall around any established special-status plant species buffer areas to prevent encroachment by construction vehicles and personnel; a qualified biologist will determine the exact location of the fencing.[6]	X	X	X	X	X	X	X	X
	• Conduct pile driving with vibratory hammer.[6]	—	—	—	X	X	X	X	—

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	• Monitor underwater sound generated by impact and vibratory hammers during pile installation. Monitoring shall be conducted to verify that sound level criteria are not being exceeded as calculated in the project description. If levels are exceeded, NMFS shall be notified and work halted until corrective actions are instituted to achieve sound level criteria.	—	—	—	X	X	X	X	—
	• Implement turbidity monitoring during construction/removal.[6]	X	X	X	X	X	X	—	X
	• Mitigation Measures for Hook and Line Sampling: ○ Implement environmental awareness program for construction personnel.[6] ○ Implement measures to decrease injury/mortality for predatory fish control hook and line sampling:[8] ○ Do not use soft lures or live bait. ○ For bait fishing, a circle hook will be used to minimize potential for injury, but may be barbed. ○ All listed fish (salmonids, green sturgeon) will be handled as little as possible. Remove hook from the captured fish while the fish is still in the water and release the fish as soon as possible with the minimal amount of handling required to complete the release. ○ If any deviation from this protocol occurs, the methods used to unhook the fish and release it and the reasons for the deviation from the protocol will be documented. These methods may include but are not limited to: – Cutting the fishing line outside of the mouth of deeply-hooked fish and allowing the hook to remain in the fish. A deeply-hooked fish is more likely to occur with bait and when the presentation of the bait is on a “slack line” technique rather than fished on a “tight” line technique. This reduces collateral injury and excessive bleeding of the fish through attempting to remove a deeply embedded hook. Retained hooks will eventually dissolve or will naturally be expelled from these fish. – Gently holding fish for extended periods of time in the water to ensure resuscitation and recovery by providing water flow through their mouth and gills. Fish are retained until they regain normal ventilatory movement of their gills and re-establish their equilibrium in the water prior to release.	—	—	—	—	—	—	X	—
	• Measures for Invasive Aquatic Plant Control (performed by DBW): ○ Timing restrictions based on outmigration of juvenile salmonids at specific sites (e.g., no treatment before June 1 at sites with juvenile outmigration, no treatment from October 16 to March 31) ○ Survey for elderberry shrubs and treat at low tide if any elderberry shrubs are within 100 ft of the water’s edge ○ Application window restrictions on timing between repeat applications for water hyacinth ○ An aquatic pesticide application plan including BMPs.	—	—	—	—	—	—	—	X

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	○ A pesticide application log including specific information on each application ○ The Water Hyacinth Control Program Protocol and Procedures Manual and appendices that include requirements covering herbicide handling, treatment planning protocol, day of treatment protocols, and BMPs, plus the permit conditions of the two biological opinions and the NPDES permit (DBW 2009). ○ Environmental awareness training for all field crew members – Species identification and impact avoidance guidelines – Protocol for identification and protection of elderberry shrubs – Protocol for identification and protection of delta smelt, Chinook salmon, steelhead, green sturgeon, and associated protected habitats – Protocol for take of protected species – Use and calibration of equipment ○ Monitoring and monthly reporting of the following. – Pre- and posttreatment measurements of chemical residue, pH, turbidity levels, water temperature, and DO at selected sites – Water temperature and DO changes resulting from EDCP activities – Amounts, types, and dates of herbicide application at each site – Visual assessment of pre- and posttreatment conditions of treated sites to determine efficacy of treatment and any effects of chemical drift – Operational status of equipment and vessels ○ A water monitoring program requiring that a minimum of 10 percent of all treatment sites be sampled for each water type to collect and analyze Delta water quality data, and results of chemical residue and toxicity tests. ○ An environmental monitoring plan. ○ An approved monitoring protocol and sampling plan. ○ A quality assurance project plan for chemical residue and toxicity monitoring, describing procedures and protocols for data collection and analysis. ○ An annual report describing permit compliance and program findings and conclusions. ○ An annual data validation package to confirm the quality of environmental monitoring data.								

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Cultural Resources	• Where construction within areas that may contain cultural resources cannot be avoided through the use of alternative management practices, conduct an assessment of the potential for damage to cultural resources prior to construction; this may require the hiring of a qualified cultural resources specialist to determine the presence of significant cultural resources.[5]	X	—	X	—	X	X	X	—
	• Where the assessment indicates that damage may occur, and prior to land disturbance, submit a non-confidential records search request to the appropriate CHRIS which potentially includes the following in the plan area.[1, 5] ○ Calaveras County: Central California CHRIS Information Center[5] ○ Mariposa County: Central California CHRIS Information Center[5] ○ Merced County: Central California CHRIS Information Center[5] ○ San Joaquin County: Central California CHRIS Information Center[5] ○ Stanislaus County: Central California CHRIS Information Center[5] ○ Tuolumne County: Central California CHRIS Information Center[5] • Implement the recommendations provided by the CHRIS information center(s) in response to the records search request.[5] • Where adverse effects on cultural resources cannot be avoided, undertake additional CEQA review and develop appropriate mitigation to avoid or minimize the potential impact(s).[5]	X	—	X	—	X	X	X	—
	• To avoid a potentially significant impact on New Melones, New Don Pedro, and New Exchequer dams due to construction and operation of water temperature control structures, a Cultural Resource Management (CRM) strategy shall be incorporated prior to the addition of any temperature controls. An appropriate CRM strategy for recording and evaluating the New Melones, New Don Pedro, and New Exchequer dams would include a records search of the area of potential effects of these projects; a field recordation of the dam and any associated historical structures on California Department of Recreation series 523 forms, specifically 523B (building, structure, or object) and/or 523E (linear resource); and the submission of these materials and any nominating materials to the State Historical Resources Commission of the California Office of Historic Preservation.	—	—	—	X	—	—	—	—
	• Require a professional trained to identify evidence of cultural resources to observe major excavation and earth-moving activities if significant cultural resources are known to exist on the project site or if there is a high probability for significant cultural resources to exist.[2]	X	—	X	—	X	X	X	—

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	• Construction will stop within a 100-foot radius of any archaeological, paleontological, or historical resources discovered during construction activities, and treatment measures will be devised as needed. A qualified archaeologist should be brought on site within 24 hours of the discovery. If the find is determined to be significant, a full archaeological survey will take place. Construction activities in the area resumes once the survey is completed and all cultural resources are recovered.[2, 6]	X	—	X	—	X	X	X	—
	• No further excavation or other site disturbance takes place if any human remains are discovered during construction activities. Notify the local coroner so that a determination can be made as to whether the remains are of Native American origin or whether an investigation into the cause of death is required. If the remains are determined to be Native American, the following actions would be taken. ○ The coroner notifies the NAHC within 24 hours. ○ The NAHC immediately notifies those persons believed to be the most likely descendant(s) (MLD) of the deceased. ○ Once the NAHC identifies the MLD, the MLD, with the permission of the landowner, inspects the site of the discovery and makes recommendations for the treatment or disposition of the remains and any associated grave items within 48 hours (per AB 2641) of the MLD being granted access to the site. ○ The landowner is to ensure that the immediate vicinity of the remains, established according to standard professional practices, is not damaged or disturbed by further activity until the landowner has conferred with the MLD. ○ Discussion and consultation between the landowner and MLD should take into account the possibility of multiple burials and reasonable options regarding the MLD's preferences for treatment. • If the NAHC is unable to identify an MLD, if the MLD fails to make a recommendation, or if the NAHC is unable to mediate a dispute concerning the appropriate disposition of the remains, the landowner shall re-inter the human remains and any associated items with appropriate dignity on the property in a location not subject to further subsurface disturbance; and, to protect the remains from disturbance, the landowner must record the site with the NAHC or the appropriate CHRIS, use an open space or conservation zoning designation or easement, and/or record a document with the county in which the property is located.[2, 5]	X	—	X	—	X	X	X	—
	○ No further disturbance of an area, if fossils are encountered, will occur until the materials have been evaluated by a qualified paleontologist and appropriate treatment measures have been identified.[4]	X	—	X	—	X	X	X	—
	• Construction workers should be aware of the following protocols for identifying cultural resources: ○ If built environment resources or archaeological resources, including chipped stone (often obsidian, basalt, or chert), ground stone (often in the form of a bowl mortar or pestle), stone tools (such as projectile points or scrapers), unusual amounts of shell or bone, historic debris (such as concentrations of cans or bottles), building foundations, or structures are inadvertently discovered during ground-disturbing	X	—	X	—	X	X	X	—

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	activities, the land owner should stop work in the vicinity of the find and retain a qualified cultural resources specialist to assess the significance of the resources. If necessary, the cultural resource specialist also will develop appropriate treatment measures for the find. ○ If human bone is found as a result of ground disturbance, the land owner should notify the county coroner in accordance with the instructions described above. If Native American remains are identified and descendants are found, the descendants may—with the permission of the owner of the land or his or her authorized representative—inspect the site of the discovery of the Native American remains. The descendants may recommend to the owner or the person responsible for the excavation work means for treating or disposing of the human remains and any associated grave goods, with appropriate dignity. The descendants will make their recommendation within 48 hours of inspection of the remains. If the NAHC is unable to identify a descendant, if the descendants identified fail to make a recommendation, or if the landowner rejects the recommendation of the descendants, the landowner will inter the human remains and associated grave goods with appropriate dignity on the property in a location not subject to further and future subsurface disturbance.[5]								
Geology and Soils	• Evaluate the project site, and up- and down-gradient areas, for erosion potential. Design the project and implement construction and maintenance activities to prevent erosion and sedimentation.[2]	X	X	X	—	—	X	—	—
	• An MMP, which is part of the permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers, would be implemented to ensure erosion is minimized and the enhancing structures are functioning successfully.	X	X	X	—	—	X	—	—
	• Remove vegetation only when necessary and make every effort to conserve topsoil for reuse in re-vegetation of disturbed areas.[2]	X	—	X	—	X	X	X	—
	• Stabilize and revegetate all disturbed soil surfaces before the rainy season.[2]	X	—	X	—	X	X	—	—
	• Restrict stockpiling of construction materials to the designated construction staging areas and exclusive of habitats and their buffer zones.[2]	X	X	X	—	X	X	—	—
	• Employ BMPs that prevent soil or sediment from leaving construction sites, monitor them for effectiveness, and maintain them throughout the construction operations and between construction seasons. Standard measures include installation of sediment basins and traps in conjunction with grading operations; development of slope drains; stabilization of stream banks; use of hydraulic mulch, hydroseeding, straw, mulch anchored with a tackifier, polyacrylamide, rolled erosion control products (e.g., blankets and mats), earth dikes, drainage swales, and velocity dissipation devices; and installation of silt fences, fiber rolls, gravel bag berms, sandbag barriers, storm drain inlet protection, and check dams.[2]	X	—	X	—	X	X	—	—

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	• Limit to the dry season any construction activities within an area of the OHW line of drainages and lakes. Limit any construction activities within a floodplain, but above an OHW line, to those actions that can adequately withstand high river flows without resulting in the inundation of and entrainment of materials in flood flows.[2]	X	X	X	—	X	X	X	—
	• Have a professional hydrologist or licensed engineer develop an erosion control and water quality protection plan to avoid habitat degradation and ensure compliance with local and state erosion- and sedimentation-related requirements. The plan should be integrated into the construction schedule and describe how site cleanup and regrading will affect current physical conditions.[2]	X	X	X	—	X	X	X	—
	• Locate projects away from areas with unsuitable soils or steep slopes.[2]	X	—	X	—	X	X		—
	• Implement all requirements under Air Quality, above.	X	X	X	X	X	X	X	X
Greenhouse Gas Emissions	• Preserve known GHG sinks to the extent feasible and limit GHG sources as a component of project design.[2]	X	X	X	X	X	X	X	X
	• Preserve or replace onsite trees or contribute to a mitigation program providing carbon storage.[2]	X	X	X	X	X	X	X	X
	• Implement local air district controls to reduce criteria pollutant emissions and help to minimize GHG emissions. Measures to reduce vehicle trips and promote use of alternative fuels, as well as clean diesel technology and construction equipment retrofits, should be considered.[5]	X	X	X	X	X	X	X	X
	• Fuel, oil, and other petroleum products will be stored only at designated sites.	X	X	X	X	X	X	X	—
Hazards and Hazardous Materials	• Hazardous materials containment containers will be clearly labeled with the identity of the hazardous materials contained therein, handling and safety instructions, and emergency contact.	X	X	X	X	X	X	X	X
	• Storage, use, or transfer of hazardous materials in or near wet or dry streams will be consistent with California Fish and Game Code (Section 5650) and/or with the permission of CDFW.	X	X	X	X	X	X	X	X
	• Material Safety Data Sheets will be made readily available to the contractor's employees and other personnel at the work site.	X	X	X	X	X	X	X	X
	• The accumulation and temporary storage of hazardous wastes will not exceed 90 days.	X	X	X	X	X	X	X	—
	• Soils contaminated by spills or cleaning wastes will be contained and removed to an approved disposal site.	X	X	X	X	X	X	X	X
	• Hazardous waste generated at work sites, such as contaminated soil, will be segregated from other construction spoils and properly handled, hauled, and disposed of at an approved disposal facility by a licensed hazardous waste hauler in accordance with state and local regulations. The contractor will obtain permits required for such disposal.	X	X	X	X	X	X	X	—
	• Provide hazardous materials and worksite safety training for construction workers in accordance with local, state, and federal requirements including, but not limited to the Occupational Safety and Health Act, Title 9 of the Code of Federal Regulations, and Title 8 of the California Code of Regulations.[2]	X	X	X	X	X	X	X	—

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• Provide hazardous materials accidental spill response plans (and/or Hazardous Materials Management Program) and training that would outline methods, materials, and responsibilities for the response to, and clean-up of, an accidental hazardous material spill during construction of the project. At a minimum, the plans should include provisions for immediate response, containment, and cleanup of a spill, including excavation and disposal of contaminated soil and notification responsibilities. Materials needed for potential cleanup activities should be kept onsite.[2]	X	X	X	X	X	X	X	—
	• Provide a health and safety plan for construction workers that is prepared by a certified industrial hygienist; complies with all appropriate local, state, and federal regulations; and identifies specific safety measures to be followed during all phases of construction and long-term operation.[2]	X	X	X	X	X	X	X	—
	• Label all hazardous materials onsite to inform users of potential risks and train users in appropriate handling, storage, and disposal procedures.[2]	X	X	X	X	X	X	X	—
	• Protect sites from unmonitored access with fencing and signs to prevent accidental health hazards to the nearby residents.[2]	X	X	X	X	X	X	X	—
	• Identify local laws, ordinances, and building codes related to fire prevention, burning, welding, and blasting, etc., to obtain any necessary permits and adhere to permit conditions.[2]	—	—	—	X	X	—	X	—
	• Maintain an adequate number of fire extinguishers and other tools and equipment that can be used for fighting fire onsite, and ensure that personnel are trained in their use.[2]	X	X	X	X	X	X	X	—
	• Maintain a water tender during extensive welding/cutting operations.[2]	—	—	—	X	X	X	—	—
	• Identify existing underground utility lines at excavation sites prior to construction, and avoid/relocate underground utility lines in coordination with utility company/service provider; coordinate with natural gas companies and Underground Service Alert before beginning any excavation or other construction activities to ensure that pipelines are not affected.[2, 6]	X	—	X	—	X	—	X	—
	• Ensure that project activities do not weaken nearby levees.[2]	X	X	X	—	X	X	X	—
	• Prior to construction, perform pre-construction hazardous waste evaluations through record searches and on-site evaluations to potentially identify leaking underground storage tanks, facilities that have received CDOs or CAOs for hazardous materials, or where soil contamination may be suspected (e.g., through soil discoloration or other indicators). If soil contamination is identified, test soil prior to excavation to determine if construction site would be located in area with soil contamination. Areas to be excavated will undergo soil and/or groundwater testing (if groundwater is present in excavated area) at a certified laboratory, provided existing data cannot characterize the nature and concentration of the contamination. Where concentrations exceed applicable federal or state thresholds, contaminated areas will be avoided or soil and/or groundwater will be remediated and contained in compliance with applicable state and federal laws. If hazardous materials are encountered, consultation with DTSC will be required to establish if a permit and subsequent actions are needed to appropriately handle the materials.	X	X	X	—	X	—	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
Hydrology and Water Quality	• Prepare a SWPPP that includes specific types and sources of storm water pollutants, determines the location and nature of potential impacts, and specifies appropriate control measures to eliminate any potentially significant impacts from storm water runoff on receiving waters. The SWPPP will require treatment BMPs that incorporate, at a minimum, the required hydraulic sizing design criteria for volume and flow to treat projected storm water runoff. The SWPPP shall comply with the most current standards established by the regional water quality control board. BMPs shall be selected from the local agency's Storm Water Quality Control Standards.[4,6]	X	X	X	X	X	X	X	X
	• Implement turbidity monitoring during construction/removal.[6]	X	X	X	X	X	X	X	X
	See Agriculture and Forestry Resources in this table for additional applicable mitigation measures.								
Noise	• Implement noise-reducing construction practices such that noise from construction does not exceed applicable local noise standards or limits specified in the applicable county ordinances and general plan noise elements. Typically construction is limited to 7:00 am–6:00 pm on weekdays and permit no work on Saturdays, Sundays, or holidays unless appropriate city and county building officials grant prior approval.[2, 3, 5, 6]	—	—	—	X	X	X	X	X
	• Use noise-generating equipment during periods when fewer people are present near the construction area.[2]	—	—	—	X	X	X	X	X
	• Muffle or otherwise control all construction equipment with a high noise-generating potential, including all equipment powered by internal combustion engines.[2]	—	—	—	X	X	X	X	X
	• Use newer equipment with improved noise muffling, and ensure that all equipment items have the manufacturers' recommended noise abatement measures, such as mufflers, engine covers, and engine vibration isolators, intact and operational. Newer equipment will generally be quieter in operation than older equipment. All installation equipment should be inspected at periodic intervals to ensure proper maintenance and presence of noise control devices (e.g., mufflers and shrouding).[3]	—	—	—	X	X	X	X	X
	• Shroud or shield all impact tools.[2]	—	—	—	X	X	X	X	X
	• Locate all stationary noise-generating equipment, such as compressors, as far as possible from adjacent occupied offices, residents, or sensitive habitats (if they are adjacent to the project site).[2]	—	—	—	X	X	X	X	X
	• Turn off mobile equipment and machinery when not in use to reduce noise from idling equipment.[2]	—	—	—					
	• Use temporary noise barriers or curtains along installation boundaries or partial enclosures around continuously operating equipment.[2]	—	—	—	X	X	X	X	X
	• Use the shortest possible routes from construction sites to local freeways for truck delivery routes, except when selecting routes to avoid going through residential neighborhoods.[2]	—	—	—					
	• Establish an active community liaison program that notifies landowners within 300 ft of construction areas of the construction schedule, in writing, prior to construction to keep them informed of schedule changes, and designate a "disturbance coordinator" for the construction site.[2]	—	—	—	X	X	X	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• Regularly inspect equipment and monitor noise and vibration to ensure that all equipment on the site is in good condition and effectively muffled and that contractors take all reasonable steps to minimize impacts, particularly when near sensitive areas.[2, 3]	—	—	—	X	X	X	X	X
	• Monitor construction noise and vibrations and modify and/or reschedule construction activities if monitoring determines that maximum limits set by local or regional noise ordinances are exceeded.[2, 3]	—	—	—	X	X	X	X	X
Recreation	• Navigational buoys, lights, and signage will be installed in sloughs upstream and downstream from the barriers to advise boaters about the presence of the barriers and maintain navigation along waterways. The project proponent will coordinate with the U.S. Coast Guard on signage and buoys.	—	—	—	—	—	X	—	—
Transportation and Traffic	• Use signage, striping, fencing, barricades, and other physical structures to mark the excavated areas, promote safety, and minimize pedestrian/bicyclist accidents.[2]	X	X	X	X	X	X	X	X
Operation									
Biological Resources	• Develop a mitigation and management plan (MMP) in coordination with CDFW and USFWS to implement all appropriate measures as required by USFWS ESA Section 7 consultation and to satisfy any other local, state, and federal requirements for achieving no net loss of wetlands, riparian habitat or other critical habitat, or take of wildlife species of concern. The plan should be submitted to the local city/county environmental planning department, U.S. Army Corps of Engineers, USFWS, CDFW, applicable regional board (e.g., as part of a Clean Water Act Section 401 Water Quality Certification application), and/or other oversight agencies as applicable for approval prior to its implementation if an impact on special-status species population(s) is determined to occur based on the biological assessment and evaluation of the final project site and design.[2]	X	X	X	X	X	X	—	—
	• Properly contain or remove all trash that may attract predators to the worksite during operation.[2]	X	X	X	X	X	X	X	X
Geology and Soils	• As discussed under Biological Resources above, an MMP, which is part of the permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers, would be implemented to ensure erosion is minimized and all structures are functioning successfully.	X	X	X	—	—	X	—	—
Greenhouse Gas Emissions	• Implement local air district controls to reduce criteria pollutant emissions and help to minimize GHG emissions. Measures to reduce vehicle trips and promote use of alternative fuels, as well as clean diesel technology and construction equipment retrofits, should be considered.[5]	X	X	X	X	X	X	—	X
	• Use vehicles with zero-emission or lower-emission engines.[2]	X	X	X	X	X	X	X	X
	• Limit the unnecessary idling of vehicles and equipment.[2]	X	X	X	X	X	X	X	X
	• Use low/zero carbon/alternative fuels, such as B20 biodiesel or renewable diesel.[2]	X	X	X	X	X	X	X	X
	• Control visible emissions from off-road diesel powered equipment.[2]	X	X	X	X	X	X	X	X
	• Encourage ride sharing and use of transit transportation for construction employees commuting to the project site.[4]	X	X	X	X	X	X	X	X

Resource	Potential Mitigation Measure	Floodplain and Riparian Habitat Restoration	Gravel Augmentation	Enhanced In-Channel Complexity	Improve Temperature Conditions	Fish Screens	Physical Barriers in Southern Delta	Predatory Fish Control	Invasive Aquatic Vegetation Control
	• Use electric equipment for construction whenever possible in lieu of fossil fuel-powered equipment.[4]	X	X	X	X	X	X	X	X
Hydrology and Water Quality	• As discussed under Biological Resources above, an MMP, which is part of the permitting requirements and conditions by resource agencies including USFWS, CDFW, Central Valley Water Board, and U.S. Army Corps of Engineers, would be implemented to ensure no erosion is occurring, water quality remains the same or is improved, any changes in hydraulics are what is expected, and the project is functioning successfully.	X	X	X	X	X	X	—	X

Sources: [1]North Coast Regional Water Quality Control Board 2009, [2]Central Valley Water Board 2010a, [3]California Regional Water Quality Control Board, Los Angeles Region 2011, [4]City of Tracy 2011, [5]Central Valley Water Board 2010b, [6]DWR 2011c, [7]SFPUC 2007, [8]NMFS 2014b, [9]ICF Jones & Stokes 2013, [10]CALFED 2000b.

Notes:

[a] Until such time that these potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. However, it is likely that impacts would be mitigated to less than significant once mitigation measures were implemented.

[b] Potential mitigation measures for conflicts with habitat conservation plans, natural community conservation plans, or other plans, policies, and regulations protecting biological species and resources that maybe attributable to land use and planning are presented in the Biological Resources sections in this table.

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16.7 Cumulative Impacts

This section evaluates the cumulative impacts associated with other indirect actions, additional actions, and methods of compliance described in Sections 16.2, *Lower San Joaquin River Alternatives—Other Indirect Actions*, 16.3, *Lower San Joaquin River Alternatives— Non-Flow Measures,* and 16.4, *Southern Delta Water Quality Alternatives— Reasonably Foreseeable Methods of Compliance*. Cumulative impacts are defined in the State CEQA Guidelines (Cal. Code Regs., tit. 14, § 15355) as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts." A cumulative impact occurs from "the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time." (Cal. Code Regs., tit. 14, § 15355, subd. (b).) State CEQA Guidelines recommend either a list or projection approach, the use of which must be guided by the standards of practicality and reasonableness. The State Water Board has decided to prepare a cumulative impact discussion for all actions presented in this chapter to disclose potential cumulative effects. However, given the lack of specificity for the actions described in this chapter over time, and in particular geographies, the analysis is necessarily general and broad. Furthermore, while lead agencies or other entities could take one or more of the actions described in this chapter, the combination of indirect actions, non-flow measures, and other actions in response to the alternatives is speculative and unknowable and, as such, the number of actions taken over time and in different locations cannot be identified. For example, not any one non-flow measure alone could fully inform adaptive implementation and, as such, various actions and measures may be combined. Specific combinations of measures cannot be predictably aligned with the alternatives because entities could take one or more of these non-flow measures and the combination of measures that entities would take under each alternative is speculative and unknowable. Because of the unknown location, scope, timing, and magnitude of potential impacts described in Sections 16.2 through 16.4, projects or programs adequately similar in nature, location, and type cannot be identified that would result in a meaningful comparative analysis. As such, to the extent feasible, possible impacts on each resource area are considered cumulatively in this section in combination with similar possible impacts in the plan area and the extended plan area, without reference to specific contributing projects.

Potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, are also incorporated and discussed, if appropriate. In some circumstances, the effects prior to implementing the mitigation measures would not be cumulatively considerable because of the localization of potential effects or the possible separation in time and space of potential effects. In these cases, the mitigation measures would serve to further reduce potential cumulatively considerable effects. In other circumstances, the mitigation measures may reduce cumulative effects to less than cumulatively considerable; however, the potential mitigation measures cannot be enforced by the State Water Board because they require actions by lead agencies or third parties over which the State Water Board has no decision-making authority. As such, the discussion identifies whether mitigation may help to reduce cumulatively considerable impacts. However, it necessarily concludes if impacts cannot be mitigated because they are beyond the enforcement of the State Water Board, cumulative impacts would be significant and unavoidable.

Aesthetics

Construction of activities described in this chapter could have temporary effects on aesthetics and the visual character and quality of an area due to the location of construction equipment, personnel, or modifying landscape features under construction. Because construction typically does not permanently alter the aesthetic quality of an area, it is unlikely that aesthetic impacts during construction would result in substantial cumulative effects in association with other construction activities and the visual character and quality in a given area. As such, impacts would not be cumulatively considerable.

Construction could create temporary light and glare during potentially needed nighttime construction periods. Given the potential location of these and the low likelihood of other sources of nighttime light and glare, this likely would not result in a cumulatively considerable impact if mitigation measures identified in Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures,* are employed. If mitigation measures are not incorporated by lead agencies or third-parties, impacts would be cumulatively considerable when considered in combination with other similar impacts in a given area.

The potential cumulative aesthetic effects depend on the location of the action, how intact and complete the visual character is of the location, and the types of sensitive viewers (e.g., recreationists) that may experience a change in the view. New facilities or structures could affect the visual character and quality of the surrounding area depending on the presence or absence of other permanent structures the type (e.g., size, bulk) of the permanent structures. If actions occur in primarily urban areas and result in new facilities or infrastructure, impacts likely would not be cumulatively considerable. If actions occur in areas without existing infrastructure, and in existing natural landscapes, the size and scale of new infrastructure could result in a substantial degradation of the surrounding visual character or quality. As such, impacts would be cumulatively considerable. Operation of the facilities could result in new sources of light or glare, that, when in combination with proximity to existing facilities could result in substantial increases in light or glare and result in cumulatively considerable impacts. Implementation of mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures,* with respect to light and glare would likely reduce cumulative effects. If mitigation measures are not incorporated by lead agencies or third-parties, impacts would be cumulatively considerable.

Operations that do not require new facilities and do not permanently and substantially alter a landscape that is intact with scenic views, or designations of scenic highways or wild and scenic rivers generally lack the potential to affect the visual character and quality of the surrounding area when considered with other projects in the general vicinity that may affect aesthetics. Impacts would not be cumulatively considerable. However, operations that permanently convert large landscapes that contain scenic views, scenic highways, or wild and scenic rivers would result in cumulative impacts because of the expected substantial change in the unique visual landscape in which the change was occurring. Permanent changes of this nature and magnitude could not be mitigated, and impacts would be cumulatively considerable.

Agricultural Resources

Agricultural land has been converted to nonagricultural uses in the Central Valley, including the plan area, due to urbanization and changing landscape. The California Department of Conservation

(CDC) indicates that since 1984 the average annual net conversation of Prime Farmland, Farmland of Statewide Importance and Unique Farmland has been approximately 38,000 (CDC 2015a). While urbanization accounts for the majority of the total loss of agricultural lands (approximately 1.1 million) between 1984 and 2010, there are other causes for farmland loss including ecological restoration projects that totaled a loss of more than 291,000 acres between 1984 and 2010 (CDC 2015a). Trends in San Joaquin, Stanislaus, and Merced Counties generally show a decline in agricultural lands as supported by the statewide trend (CDC 2015b). However, there are also tradeoffs between Prime, Unique, and Farmland of Statewide Importance where Prime Farmland may annually decrease but Unique Farmland increase (CDC 2015b). The construction and operation of most of the activities described in this chapter would not result in temporary or permanent impacts on agricultural resources. This is because either the location of the activity would not be in or adjacent to agricultural uses or because the activity would support agricultural uses. However, if the activities result in the permanent removal of agricultural lands because of the conversion of agricultural lands to nonagricultural uses significant and unavoidable cumulative impacts could occur. While potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, identify mitigation, if permanent loss occurs because significant acreage is converted to nonagricultural use (e.g., restoration projects), impacts would be cumulatively considerable, when considering the larger context for the loss of designated agricultural lands.

Forests are typically managed in California for multiple purposes including recreation and resource extraction. Trees are periodically harvested and replanted depending on a particular forest management plan and projected demand for timber within an area. It is unlikely that there would be another project similar to that of new surface water reservoirs that would completely and permanently remove forestland. As such, while the impact is significant, it would not be cumulatively considerable because no other project is expected to have a similar type of impact.

Air Quality

Construction emissions associated with actions described in this chapter would be short term. Because cumulative impacts, by definition, are long-term, construction emissions are not anticipated to result in cumulatively considerable impacts on air quality. Additionally, implementation of potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, for air quality emissions generated during construction would serve to further reduce, or minimize, or eliminate air quality emissions for actions identified in this chapter. Air quality emissions from vehicle trips used for either monitoring or maintenance, or from back-up generators could result. Vehicle trips would be limited in duration and would occur discretely over time and in many different locations. As such, these emissions would not be cumulatively considerable.

The air basins where potential actions could be located (i.e., SJVAB, MCAB, GBVAB) are in nonattainment for a variety of emissions (e.g., ozone, PM2.5, PM10). As such, air quality emissions from regularly operating new equipment could generate long-term emissions that contribute to nonattainment because of the daily operation of different facilities, in different locations over the lifetime of the facility. In addition, if numerous truck trips are required under operating conditions to transport or dispose of materials, the number of trucks, duration of the trips generated, and travel routes could result in cumulative air quality impacts within these air quality basins or others that are in nonattainment. Although implementation of mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, could reduce the generation of emissions during operating conditions, impacts would be cumulatively considerable. If mitigation measures are not incorporated by lead agencies or third parties, impacts would be cumulatively considerable.

Biological Resources

The plan area, and to a lesser extent, the extended plan area, has been subjected to extensive changes due to land conversion to agricultural and urban uses, water development, population growth, and recreation. These changes have altered the physical and biological integrity of the Central Valley, causing loss of native riparian vegetation along river systems, loss of wetlands, and loss of native habitat for plant and wildlife species. Many of the biological impacts from the actions evaluated in this chapter can be mitigated, due to the temporary nature (short duration in time and location) of construction, with potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*. If, depending on the project-specific construction timeline and type of construction, the impacts are short in duration, temporary, and localized and do not result in *take* of a species, then impacts would not be cumulatively considerable. However, if mitigation measures are not incorporated by lead agencies or third parties, impacts would be cumulatively considerable.

Construction may permanently remove or substantially degrade sensitive habitat, remove species, and result in *take* because of the potential mechanisms needed for construction (e.g., building cofferdams). As such, the potential mitigation measures may not be sufficient to reduce effects during construction. The cumulative impact of the significant reduction in quality habitat and the take of individual listed plants or wildlife species would be cumulatively considerable when viewed in combination with similar impacts in the area.

Operation could result in effects on biological species if they represent a continual degradation or on-going effect on existing special-status species or habitat. While monitoring, or potentially adaptive management, could be done to assess the effects of the operation on biological resources, and adjustments of operation could be made, impacts would be cumulatively considerable when viewed in combination with similar impacts in the area.

Cultural

Ground-disturbing activities associated with most of the actions evaluated in this chapter could result in cumulatively considerable effects on cultural resources if performed in combination with other ground-disturbing activities. Effects would be localized and primarily related to construction because ground-disturbing during construction tends to result in discovery of cultural resources and can result in the potential destruction of those resources. Implementation of potential mitigation measures for cultural resources identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, during construction would reduce the contribution to this impact to a level that is not cumulatively considerable. The potential mitigation measures would ensure identification of cultural resources and minimization of impacts on identified resources either through removal and preservation or modification of project location or construction methods. If mitigation measures are not incorporated by lead agencies or third-parties, impacts would be cumulatively considerable when viewed in combination with similar impacts in the area. In addition, even with mitigation, due to the potential expansive and large scale ground disturbing activities associated with the construction of new surface water reservoirs, impacts would remain cumulatively considerable because they could result in the complete destruction of known or unknown cultural resources.

Geology and Soils

Geology and soils could be affected during construction activities associated with the actions evaluated in this chapter because of disturbance of soil. Construction effects on geology and soils would generally be localized and temporary. In many instances, it would also be relatively short in duration. As such, it is unlikely that cumulatively considerable effects on geology and soils would occur in association with other construction activities in any given area. Therefore, the impacts would not be cumulatively considerable. In addition, potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, would serve to further reduce impacts during construction associated with geology and soils.

Once facilities are in place, operating conditions would not bring or expose people to significant risk of earthquakes, landslides, unstable soils, or other geologic hazards, and therefore could not result in a continued disturbance of soils or geology. However, if operations result in continued or increased groundwater pumping at levels that would lead to overdraft conditions in the groundwater basin, they could result in a continued disturbance of soils or geology.

Greenhouse Gases/Climate Change

Unlike other air quality emissions (e.g., criteria pollutants), GHG emissions occur at a global level. The relatively long lifespan and persistence of GHGs require that climate change be considered a cumulative and global impact. While it is unlikely that increases in global temperature or sea level could be attributed to the emissions resulting from a single project, it is appropriate to conclude the GHG emissions from the actions described in this chapter (if they were to occur) would combine with GHG emissions in California, the United States, and the globe to cumulatively contribute to global climate change. In addition, given the ZEL standard recently implemented by the SJVAPCD, GHG impacts from implementation of these activities may not be negligible. Because it is unknown to what extent climate change would be affected by the incremental GHG emissions produced, the impact on GHG and climate change would be cumulatively considerable. Implementation of potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, for the actions identified above, would result in lower GHG emissions levels than had they not been incorporated. However, these mitigation measures would not completely eliminate GHG emissions. As such, impacts would be cumulatively considerable.

Hydrology and Water Quality

Urbanization and the development of agriculture has led to significant alteration of hydrology and water quality in the plan area and extended plan area over time. The alteration has led to surface water resources that are fully managed in accordance with a complex set of existing laws, regulations, and policies and by multiple dams and diversions. Groundwater resources have been less managed than surface water resources; however, they, too, have been greatly altered and substantially reduced through urbanization and the development of agriculture.

During construction of some of the actions evaluated in this chapter, the disturbance of soil and working within or adjacent to rivers and water ways could result in localized and temporary effects on hydrology and water quality. As such, it is unlikely that cumulatively considerable effects would on hydrology and water quality would occur in association with other construction activities or projects in any given area, and impacts would not be cumulatively considerable. In addition, potential mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, would serve to reduce impacts during construction associated with hydrology and water quality.

Impacts would not be cumulatively considerable if there are no substantial and permanent effects on hydrology or water quality under operating conditions because of small operating footprints of the facilities, limited generation of substantial amounts of runoff or discharges, or the purpose of the activity is to treat water or wastewater prior to discharge or use. Substantial and permanent effects on hydrology and water quality could occur due to the alteration of a river through the development and operation of substantial infrastructure (e.g., new surface water reservoirs). While potential mitigation measures, alternative locations, or alternative project designs (currently unknown) could reduce cumulative effects, given the potential size and scale of infrastructure projects, impacts would be cumulatively considerable and significant.

Hazards and Hazardous Materials

Within the plan area and extended plan area, projects must comply with all existing hazardous material regulations through the local, state, and federal government. These regulations are in place to reduce the potential of accidental releases, spills, or explosions of hazardous materials and to minimize the environmental and public health impacts should one occur. Although projects cannot completely eliminate the probability associated with an accidental release, explosion, or spill, the existing regulations reduce the overall probability and minimize the impacts during a release.

Hazardous materials are typically used during construction (e.g., fuels and lubricants) of the actions evaluated in this chapter. However, the transport of significant quantities of hazardous materials or waste would not occur and would not involve the handling or disposal of significant quantities of hazardous materials or waste. In addition, the use would be temporary and localized within the area of construction. Because the hazardous material use and disposal would be intermittently located, it is unlikely that use during construction activities would result in a substantial cumulative effect in association with other uses in any given area. As such, no cumulatively considerable hazardous impacts would occur as a result of construction activities. In addition, implementation of potential mitigation measures associated with the handling of hazardous materials during construction identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, would serve to further reduce, or minimize, hazardous impacts.

Construction could result in disrupting existing underground utility lines during ground-disturbing activities. However, this would be highly localized and infrequent in time and, as such, would not result in impacts that are cumulatively considerable. In addition, mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures,* of identifying utilities prior to ground-disturbing activities would further reduce impacts. Construction activities may also disturb known or unknown hazardous materials in soil or groundwater depending on the type of ground disturbing activity and the type of activity; however, mitigation measures identified in Table 16-38 would reduce impacts to less than cumulatively considerable because materials would be remediated and removed if they were discovered. However, if mitigation measures are not incorporated by lead agencies or third-parties, impacts would be cumulatively considerable.

Activities that involve the regular handling and transport of hazardous materials could result in a cumulatively considerable impact if they do so in conjunction with many other projects that also handle and transport hazardous materials. The mitigation measures identified in Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures,* would reduce impacts to less-than-significant levels; however, given the use of hazardous materials application in the waterways and use at existing facilities, until the mitigation was implemented, impacts would be cumulatively considerable and significant.

Noise

Noise from construction activities associated with actions evaluated in this chapter would be highly localized. Because noise-sensitive land uses are intermittently located, it is unlikely that noise from construction activities would result in a substantial cumulative effect associated with other noise sources, particularly related to construction, in any given area. As such, no cumulatively considerable noise impacts would occur as a result of construction activities. In addition, implementation of potential mitigation measures associated with noise identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, generated during construction would serve to further reduce or minimize noise levels associated with construction.

Noise from operating activities could result primarily from either vehicle trips, used for monitoring or maintenance, or from operation of new equipment. Noise from vehicle trips would be spread throughout the roadway system and may contribute to traffic noise. However, monitoring or maintenance trips would be limited in duration and spread over time. As such, impacts would not be cumulatively considerable. Operation of equipment could produce permanent noise. Some of the noise generated would occur in areas with existing facilities that generate noise. While it is anticipated that noise generated by these facilities would be reduced and dampened through the use of walls, structures, or other facilities as described in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* and Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures*, unless these measures are implemented, impacts would be cumulatively considerable, given the proximity to other permanent noise-generating facilities.

Mineral Resources

Projections indicate mineral resources, particularly aggregate, is decreasing overall as population increases, which is putting pressure on existing mineral sources along the Stanislaus, Tuolumne, and Merced Rivers (Clinkenbeard 2012a; Smith and Clinkenbeard 2012). Construction and operation of the following could result in temporarily or permanently removing mineral resources from use: floodplain and riparian habitat restoration, gravel augmentation, and enhancing in-channel complexity and new surface water supplies. There is a low potential for floodplain and riparian habitat restoration and enhancing in-channel complexity to permanently remove mineral resources from use given how they would be constructed and the conditions needed for construction. However, removal of additional mineral resources, particularly under gravel augmentation and new surface water supplies, would be cumulatively considerable when considered with other similar impacts in the area. Although mitigation measures identified in Table 16-39, *Potential Mitigation Measures for Construction and Operation Activities Related to Non-Flow Measures,* could reduce impacts, until the mitigation was implemented, impacts would be cumulatively considerable and significant.

Land Use and Planning, Population and Housing, and Public Services

General and specific plans and zoning codes allow for the construction and operation of different land uses in designated areas within the jurisdiction of local agencies. Local agencies have the discretion to modify or conditionally approve uses that may not be specifically approved for a particular area. Construction and operation involving public infrastructure or facilities evaluated in this chapter are typically allowed in multiple land use designations and zoned areas (e.g., public facilities, residential, industrial, open space overlays) and, as such, have a limited potential to affect land use and planning or conflict with local policies and plans when considered with other projects that may also involve infrastructure or facilities. In addition, there would be limited potential for effects on land use and planning where construction and operation of new facilities would be at existing infrastructure or facility locations already allowed by local policies and plans. Construction and operation that does not involve infrastructure or facilities also has a limited potential to affect land use and planning. Some of these actions may occur adjacent to or within waterways, and frequently these areas are designated natural resource or open space areas by land use plans. If inconsistencies were identified, they would not result in cumulatively considerable impacts because amendments would be processed, as required, to reduce impacts. Given the above, there would be no cumulative impacts.

Construction and operation would likely not result in an increase in population, the need for housing or public services, because many of the activities would either be restoration-type activities that have no effect on population, housing, or public services or because the activities would provide replacement water supplies and, as such, would not provide a supply to meet a new or an increase in demand. As such, cumulative impacts would not occur and impacts would not be cumulatively considerable. However, new surface water reservoirs would likely require public services, depending on the size and location of the reservoir. The ability to satisfy the needed services depends on the types of services currently in place and their ability to absorb additional demand; however, this would be highly localized and as such is not expected to result in cumulatively considerable impacts. In addition, mitigation measures identified in Table 16-38 would be expected to further reduce impacts.

Construction could impair the implementation of or physically interfere with an existing emergency response or emergency preparedness plan, or require the preparation of a new emergency response or emergency preparedness plan. However, projects would be required to coordinate with all law enforcement agencies during construction of all roadway improvements to establish emergency vehicular access, ensuring continuous law enforcement access to surrounding areas. Furthermore, police and fire stations are generally distributed to facilitate quick emergency response throughout the plan area and extended plan area, as applicable. If emergency plans are affected, they would only affect emergency plans during construction. Given the infrequent of activities over time and geography and the limited nature of potential impacts, impacts would not be cumulatively considerable.

Recreation

If construction is located near recreation facilities, and facilities may be indirectly affected by construction, cumulative impacts could occur as discussed under other resources (e.g., noise). However, these impacts would last during the construction period only and would return to levels comparable to those that existed prior to construction once construction is complete. Furthermore, in the event that patrons do visit other facilities due to project construction activities, it is not expected that patrons would use facilities in a manner that would cause or accelerate substantial physical deterioration of those facilities. It is expected that the demand for alternative recreation resources would be distributed among the large number of parks and recreational facilities in the area and region, and would likely return to original recreation resources once construction activities cease.

Activities that permanently alter or remove highly specialized or designated recreational resources (e.g., white water rafting) could have cumulative impacts (e.g., new surface water reservoirs). Depending on the type of existing activity and whether it is relatively limited in time and geography, the loss of that opportunity may be cumulatively considerable and could not be mitigated given the potential complete loss of the recreational resource.

Transportation and Traffic

Construction of the actions evaluated in this chapter has a limited potential to affect level of service on existing roads given that construction would be relatively temporary in duration and because typically, roadways return to preconstruction levels of service once the construction is completed. In addition, construction that occurs in remote areas away from other construction or operating projects would not result in cumulatively considerable impacts.

Transportation and traffic impacts from operational activities could result primarily from vehicle trips used for monitoring or maintenance. However, monitoring or maintenance trips would be limited in duration and spread over time. In addition, for those that would be located within proximity to existing facilities or infrastructure maintenance or monitoring likely would not result in any additional trips beyond what currently may be needed for existing facilities. As such, impacts would not be cumulatively considerable.

Transportation and traffic impacts from operating activities that result in a permanent and regular increase of traffic on roadways depends on frequency of trips, designated haul routes, and final destination. If haul routes are located in urban areas, on heavily traveled roads, they may result in a decrease of levels of service on existing roadways. Transportation and traffic impacts that result from the use of new amenities (e.g., recreation at a reservoir) would depend on the location of the amenity, the service provided, and the season of operation. This could be a highly localized effect. Furthermore, regional and local plans typically project traffic levels over time to accommodate increases in traffic within planning frameworks. As such, impacts would not be cumulatively considerable.

Utilities and Service Systems (Service Providers)

Construction and operation of the actions evaluated in this chapter would not be expected to exceed wastewater treatment requirements of the Central Valley Water Board either because the action would not involve the discharge of wastewater or because the action would improve wastewater discharge entering a receiving water. Additionally, most actions would not result in the discharge of wastewater and, therefore, would not require the construction or operation of wastewater treatment facilities. Most actions do not result in an increased demand for wastewater treatment and, as such, would not result in the determination by a wastewater treatment provider that it has inadequate capacity to serve the action. Accordingly, impacts would not be cumulatively considerable.

Where construction and operation of new septic or closed vault toilet systems would be required, design requirements would be followed. In addition Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* includes mitigation measures. Since the construction and operation of septic tanks or close vaulted toilet systems are relatively localized, the implementation of these mitigation measures would reduce impacts on the environment such that the construction of these facilities for new surface water storage facilities would not be cumulatively considerable when considered in combination with other projects with similar impacts.

Solid waste generated during construction of actions would be a temporary increase in the generation of solid waste and would not result in a cumulatively considerable impact on existing solid waste disposal locations. Actions that require regular disposal of waste could generate a reoccurring volume of waste depending on the generation requirements. However, disposal of all solid waste (including brine from desalination actions) would be done in accordance with all applicable federal, state, and local regulations and guidelines. Therefore, impacts would not be cumulatively considerable.

Construction or operation of new wastewater or water treatment facilities could occur. Implementation of these actions could result in impacts on multiple resources (e.g., air quality, noise, biological resources), and would be cumulatively considerable when considered with other similar impacts in the area. Although mitigation measures identified in Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* could serve to reduce impacts, until the mitigation was implemented, impacts would be cumulatively considerable and significant.

Construction and operation of the actions evaluated in this chapter would likely not require new stormwater infrastructure or the expansion of existing infrastructure. Where construction of new stormwater drainage facilities would be required, surface water drainage design would be required to be followed. In addition Table 16-38, *Potential Mitigation Measures for Construction and Operation Activities Related to Other Indirect and Additional Actions,* includes mitigation measures that require stormwater runoff control systems to fit the hydrology of the plan area, have adequate capacity, and be non-erosive. Since the construction and operation of stormwater drains are relatively localized and occur within an existing area of service, the implementation of these mitigation measures would reduce impacts on the environment such that the construction of these facilities for new surface water storage facilities would not be cumulatively considerable when considered in combination with other projects with similar impacts.

16.8 References

16.8.1 Printed References

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Chapter 17
Cumulative Impacts, Growth-Inducing Effects, and Irreversible Commitment of Resources

17.1 Introduction

This chapter describes the cumulative impacts associated with the Lower San Joaquin River (LSJR) and southern Delta water quality (SDWQ) alternatives together with other projects (and programs) that could cause related impacts. In accordance with the California Environmental Quality Act (CEQA) Guidelines (California Code of Regulations [Cal. Code Regs.], tit. 14, § 15130) requirements, this chapter discusses the cumulative impacts of the LSJR and SDWQ alternatives in conjunction with other past, present, and reasonably foreseeable probable future projects. Present and reasonably foreseeable probable future projects are projects that are currently under construction, approved for construction, have submitted a request for approval or review by an agency, or are in the final stages of formal planning.

This chapter provides an analysis of the potential cumulative impacts, organized by resource area, which would result from the implementation of the proposed project (the LSJR and SDWQ alternatives, or plan amendments) and the other projects, described in Section 17.2.1, *Projects Considered*, of this chapter. The resource areas correspond with the resource chapters (Chapters 5–14) of this recirculated substitute environmental document (SED). The cumulative impacts associated with the No Project Alternative (LSJR/SDWQ Alternative 1) are discussed in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*. The cumulative impacts associated with other indirect and additional actions are discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

This chapter also fulfills the CEQA requirement to describe the growth-inducing impacts of a proposed project. This chapter discusses the ways in which the LSJR and SDWQ alternatives could directly or indirectly foster economic or population growth or the construction of additional projects. (Cal. Code Regs., tit. 14, §15126.2, subd. (d).)

Finally, this chapter fulfills the CEQA requirement to disclose any significant irreversible environmental changes that could potentially result from implementation of the LSJR and SDWQ alternatives. (Cal. Code Regs., tit. 14, § 15126.2, subd. (c).)

17.2 Cumulative Impacts

17.2.1 Projects Considered

Cumulative impacts are defined in the State CEQA Guidelines as “two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.” (Cal. Code Regs., tit. 14, § 15355.) A cumulative impact from several projects is “the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonable foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time." (Cal. Code Regs., tit. 14, § 15355, subd. (b).)

Overall, the LSJR alternatives would generally increase the instream flow requirements above baseline conditions. The principal potential impacts of the LSJR alternatives stem from the following factors.

- Reduced availability of surface water for agricultural, municipal, and other uses that result from requiring unimpaired flows[1] to remain in the stream system for the protection of fish and wildlife.
- Changes in timing and magnitude of flows in the plan area and reduced surface water availability for diversion that in turn have effects on groundwater.
- Changes in the timing and magnitude of flows that affect reservoir levels and riverine systems.

The cumulative analysis considers adverse effects of the project identified in the resource chapters that are significant or less than significant. If an impact has been determined to have no effect, then it would not contribute to any cumulative effects and it is not discussed in this chapter.

As described in the respective resource chapters (Chapters 5–14), LSJR Alternatives 3 and 4, with or without adaptive implementation, would have a significant and unavoidable impact on the following resources in the plan area.

- Groundwater resources
- Recreational resources and aesthetics
- Agricultural resources
- Service providers
- Energy and greenhouse gases

LSJR Alternative 2 with adaptive implementation would have a significant and unavoidable impact on groundwater, agriculture, and service providers in the plan area. LSJR Alternatives 2, 3, and 4 with or without adaptive implementation would have a less-than-significant effect on the other resources addressed in this SED, each of which is also evaluated in this chapter.

SDWQ Alternative 2 would have a significant and unavoidable impact on service providers. SDWQ Alternatives 2 and 3 would have a less-than-significant impact on surface hydrology and water quality, agricultural, and energy and greenhouse gases. SDWQ Alternatives 2 and 3 would have no impact on the other resources evaluated in Chapters 5–14 this SED.

The principal effect of SDWQ Alternative 2 would stem from the potential need of wastewater treatment plant operators to construct new wastewater treatment facilities or expand existing facilities to comply with salinity objectives. The construction of new wastewater treatment facilities or expansion of existing facilities or infrastructure could cause significant environmental effects and, thus, have a significant and unavoidable impact on service providers. The indirect environmental effects, cumulative and otherwise, of these new or expanded facilities or infrastructure are

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[1] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

separately evaluated in Chapter 16, *Evaluation of Other Indirect and Additional Actions*. Statements in this chapter that an SDWQ alternative will have no impact pertains to the impact questions evaluated in Chapters 5–15 of the SED.

As described in the respective resource chapters, LSJR Alternatives 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation would have a significant and unavoidable impact on the following resources within the extended plan area.

- Aquatic biological resources
- Terrestrial biological resources
- Recreational resources and aesthetics
- Service providers
- Energy and greenhouse gases

LSJR Alternatives 2, 3, and 4 with or without adaptive implementation would have a less-than-significant effect on the other resources in the extended plan area.

The SDWQ alternatives would not have impacts in the extended plan area because (1) flows in the extended plan area are not expected to change in response to the SDWQ alternatives, and (2) the extended plan area is far upstream from the southern Delta, which means that any change in the salinity conditions in the southern Delta would not affect the water quality in the extended plan area. As such, no cumulative impact is associated with the SDWQ alternatives in the extended plan area and, therefore, are not discussed further in this chapter.

As discussed in Chapter 15, the No Project Alternative (LSJR/SDWQ Alternative 1) would have significant and unavoidable impacts on the following resources.

- Surface hydrology and water quality
- Aquatic biological resources
- Terrestrial biological resources
- Recreational resources and aesthetics
- Agricultural resources
- Cultural resources
- Service providers
- Energy and greenhouse gases

The No Project Alternative would have a less-than-significant effect on the other resources addressed in this SED.

The proposed plan amendments are analyzed at a programmatic level of detail in this cumulative effects analysis. Responsibility for implementing the objectives will be assigned in future proceedings and evaluated on a project-level basis in accordance with CEQA. Where information is not sufficient for a detailed cumulative effects analysis, or there is a high level of uncertainty as to what actions would occur and how they would affect resources, this is noted in the text and no attempt at speculation is made.

Projects with Potential Cumulative Impacts

Table 17-1 lists and describes specific projects, or categories of projects, that could have a cumulative impact and why. The description of the potential impacts of the LSJR and SDWQ alternatives on each resource is in the respective resource chapter (Chapters 5–14). Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, describes the impacts of the No Projects Alternative, including cumulative impacts.

This cumulative impact evaluation considers past projects, present projects, and reasonably foreseeable probable future projects with related effects in the San Joaquin River (SJR) Basin (including the three eastside tributary watersheds—the Stanislaus, Tuolumne, and Merced Rivers), the southern Delta, and Delta. *Present and reasonably foreseeable probable future projects* are those projects that currently exist or are sufficiently certain to allow for a meaningful analysis, such as projects that are currently under construction, approved for construction, have submitted a request for approval or review by an agency, or are in the final stages of formal planning. Cumulative effects from past projects are generally reflected in the existing environmental conditions described in the resource chapters and provide context for the geographic area of environmental effects that are included in the cumulative impact analysis.

A number of past and present projects which affect flows in the LSJR and Delta are included in baseline. However, due to their dynamic nature all possible future effects may not be fully represented by the baseline. Given their potential to have different effects due to changing conditions, the cumulative effects of the following projects, described in Table 17-1, are also considered.

- National Marine Fisheries Service (NMFS) Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project (CVP) and State Water Project (SWP) (NMFS BO)
- United States Fish and Wildlife Service (USFWS) Biological Opinion on the Long-Term Operations of CVP and SWP (USFWS BO) (delta smelt)

Table 17-1 also includes categories of projects, with examples, so that the cumulative effects of a general class of projects can be determined. For example, water transfers are included as a general category of past, present, and reasonably foreseeable probable future projects that could have a cumulative effect. While water transfers are considered reasonably foreseeable, they are temporary in nature and can vary widely year-to-year. Historically, 1–2 water transfers of approximately 4–25 thousand acre-feet (TAF) occur annually within the plan area, as defined in Chapter 1, *Introduction*. These historical water transfers can be used to estimate the frequency and volumes of transfers that may occur in the future.

Table 17-1. Cumulative Project List

Project: California High Speed Rail Project

Status: Future—project development is ongoing

Location: San Francisco Peninsula, Santa Clara Valley, San Joaquin Valley, Antelope Valley, San Fernando Valley, and Los Angeles Basin

Project description: This project would involve the planning, design, construction, and operation of a high speed rail system connecting major population centers across California. Phase 1 of the project would run from San Francisco to the Los Angeles Basin (to be completed by 2029). Phase 2 of the project would extend the system to Sacramento and San Diego (no scheduled completion date). Once completed, the system would have up to 24 stations covering 800 miles. Construction of the system could create thousands of jobs and boost economic development across the state, encouraging population growth. Once completed, the project would improve environmental quality by reducing greenhouse gas (GHG) emissions from other forms of transportation.

Resource areas with potential cumulative effects:

- Groundwater resources
- Agricultural resources
- Service providers
- Energy and greenhouse gases

This project is expected to encourage population growth. This could increase water use in the region, which has historically relied on groundwater supplies. Therefore, it can be presumed that increased water demand would increase groundwater pumping, thereby affecting groundwater resources, reducing water availability for agricultural uses, and requiring service providers to meet the increased water demand. In addition, while the completed project is expected to reduce GHG emissions, construction would rely on considerable use of heavy equipment and construction vehicle trips, which could lead to increased GHG emissions. Thus, the project could have a related effects as the plan amendments on groundwater, agriculture, service providers, and energy and greenhouse gases.

Project: California WaterFix

Status: Future—project development is ongoing

Location: Delta

Project description: This project is proposed by the California Department of Water Resources (DWR) as a new State Water Project (SWP) Delta facility that would include three new screened intakes on the Sacramento River in the northern Delta, each capable of diverting up to 3,000 cubic feet per second (cfs) of water. This project would make physical and operational improvements to the SWP system in the Delta necessary to restore and protect ecosystem health, water supplies of the SWP and the Central Valley Project (CVP) south of the Delta, and water quality within a stable regulatory framework, consistent with statutory and contractual obligations. The Draft Bay Delta Conservation Plan (BDCP) and BDCP Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS) were made available by DWR and the U.S. Bureau of Reclamation (USBR) for public review and comment in 2013. After consideration of the public comments, which included concerns regarding the effectiveness of certain habitat restoration measures and the level of scientific uncertainty regarding future conditions associated with climate change, DWR and USBR proposed a modified preferred alternative, Alternative 4A (i.e., “California WaterFix”), in 2015.

Alternative 4A includes the water conveyance facilities originally proposed but does not include the habitat conservation plan. It also uses a different regulatory approach for obtaining the permits and authorizations needed for implementation under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA). Alternative 4A is evaluated, along with other proposed alternatives, in the Recirculated Draft EIR/Supplemental Draft EIS (RDEIR/SDEIS) that was released on July 10, 2015 for public review and comment. On August 26, 2015, DWR and USBR filed an application with the State Water Resources Control

Board (State Water Board) for changes to their water rights permits that are needed to implement Alternative 4A. The water rights process will include public participation and the opportunity to comment; the evidentiary hearing on the petition began in July, 2016.

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Aquatic biological resources
- Agricultural resources
- Service providers

This project could affect hydrodynamics (i.e., flow paths) and water quality in the Delta, including the southern Delta. If surface water is diverted in the northern Delta, in lieu of at the SWP Clifton Court Forebay and the CVP Jones Pumping Plant in the southern Delta, it could reduce the reverse flow effect that occurs when Sacramento River and San Joaquin River (SJR) flows are drawn south instead of moving west, as they would naturally, towards the San Francisco Bay. Reducing reverse flows would generally result in improved hydrologic conditions for aquatic species as both fish and food production are not drawn towards the southern Delta where chances of survival for at-risk native fish species diminish. However, drawing less Sacramento River water to the southern Delta could also result in increased salinity and generally reduced water quality in the southern Delta as Sacramento River water is less saline. In general, increased salinity could have a cumulative effect on surface hydrology and water quality, aquatic biological resources, agricultural resources, and service providers. Additionally, there could be construction-related impacts associated with the installation of new gates at Clifton Court Forebay in the southern Delta. However, specific cumulative effects of this project cannot be determined because the project will be affected by other projects, described in this table, which could also affect flows paths in the Delta and could have similar effects. These other projects include: National Marine Fisheries Service (NMFS) Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (NMFS BO); United States Fish and Wildlife Service (USFWS) Biological Opinion on the Long-Term Operations of CVP and SWP (USFWS BO) (delta smelt); and, the update to the 2006 *Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan), Phase II.

Project: Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and Central Valley-Wide Salt and Nitrate Management Plan (SNMP)

Status: Future—project development is ongoing

Location: Central Valley

Project description: This project would address salinity and nitrate problems in the Central Valley and develop long-term solutions that would lead to enhanced water quality and economic sustainability.
In 2006, the State Water Board and Central Valley Regional Water Quality Control Board (Central Valley Water Board) initiated this stakeholder effort. Near-term projects include developing the first phase of a conceptual model for salt and nitrate conditions in the Central Valley and a comprehensive and robust geographic information systems (GIS) framework to support the salt management planning effort.
The overarching goals of CV-SALTS include protecting and enhancing the environment and maintaining reliable, high-quality urban water supply, while also retaining the agricultural economy and supporting economic growth. The specific goal is to develop a salt-management plan in compliance with the state's recycled water policy. The Central Valley Water Board held a series of California Environmental Quality Act (CEQA) scoping meetings in October, 2013 for the development of an SNMP for incorporation into the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Sacramento–San Joaquin Basin Plan) and the Water Quality Control Plan for the Tulare Lake Basin (Tulare Lake Basin Plan). Additional stakeholder meetings regarding the development of the SNMP and possible amendments to the Sacramento–San Joaquin Basin Plan and Tulare Lake Basin Plan were held in June and August, 2016. The draft SNMP is expected to be completed in late 2016. This project also includes the development of new water quality objectives for salinity for the lower San Joaquin River (LSJR) upstream of Vernalis, which will be proposed as a future basin plan amendment to the Sacramento–San Joaquin River Basin Plan.

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Service providers

CV-SALTS would balance the use of assimilative capacity and the implementation of management measures. Therefore, it could change the timing and magnitude of salt discharges to the LSJR and southern Delta channels, which could affect water quality conditions in the LSJR, including salt loading. Thus, CV-SALTS could have a related effects as the plan amendments on surface hydrology and water quality and service providers.

Project: County General Plan Updates

Status: Ongoing

Location: Merced, San Joaquin, and Stanislaus Counties

Project description: General plans for counties identify land use designations, land use changes, and plans for growth. Following is a list of plans and the status of updates for the counties that can cause similar impacts as the plan amendments.

Merced—The 2030 *Merced County General Plan* was adopted on December 10, 2013. The plan is an overarching policy document that guides land use, housing, transportation, infrastructure, community design, and other policy decisions.

- San Joaquin—The draft 2035 *General Plan for San Joaquin County* was released for public comment in October, 2014. Many of the existing policies of the county's 2010 General Plan remain unchanged, but the comprehensive update reflects a new vision for future growth and development within the county. It also reflects recent state law requirements, including: Delta protection and use; flood risk protection; water and energy conservation; and GHG emissions reductions.
- Stanislaus—Revises the Land Use, Circulation, Conservation/Open Space, Noise, and Safety Elements. The update will incorporate changes in legislation, code, and local standards on a 20-year planning horizon (to 2035). There will be no changes to the Land Use map designations. The draft EIR was released for public review in April 2016.

Resource areas with potential cumulative effects:

- Agricultural resources
- Groundwater resources
- Service providers

The San Joaquin Valley is one of the fastest-growing areas in California, with urban expansion often resulting in the conversion of land from agricultural uses to nonagricultural uses. Although county general plans regulate land use conversions (e.g., Stanislaus County requires a majority of county voters to approve rezoning land designated as agricultural or open space to residential), urban expansion efforts that prioritize the implementation of water supply projects and other construction, could result in the removal of land from agricultural use in the plan area, including Important Farmland. The final EIR for the Merced 2030 General Plan and the draft EIR for the Stanislaus General Plan Update state that buildout under the plans could result in significant impacts related to groundwater depletion and recharge. The draft EIRs for the San Joaquin 2035 General Plan and the Stanislaus General Plan Update state that there would be significant impacts related to the construction of new water supply or treatment facilities or the expansion of existing facilities. Thus, these county general plans could have related an effects as the plan amendments on agricultural resources, groundwater resources, and service providers.

Project: Delta Stewardship Council (DSC) Delta Plan

Status: Future

Location: Delta

Project description: The Delta Plan addresses a range of challenges facing the Delta, including water supply reliability and Delta ecosystem health concerns. The Sacramento–San Joaquin Delta Reform Act of 2009 (California Water [Cal. Wat.] Code, § 85000 et seq.) provides for the establishment of an independent state agency, the DSC, to achieve the coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The DSC is charged with the development and implementation of a legally enforceable, long-term comprehensive management plan for the Sacramento–San Joaquin Delta to achieve the coequal goals. The Delta Plan was unanimously adopted by the DSC on May 16, 2013 and became effective on September 1, 2013. On June 23, 2016, a Sacramento Superior Court judge issued a ruling setting aside the Delta Plan because parts of it were not consistent with the Delta Reform Act and ordering the DSC to revise the Delta Plan. The decision has been appealed. Any revised Delta Plan would likely be similar to the existing plan because many aspects of the plan were upheld and are required to fulfill the statutory mandates of the Act.

The Delta Plan is intended to provide a comprehensive, long-term management plan for the Delta, and it establishes regulatory policies that would be binding on certain covered actions (as defined in Cal. Wat. Code § 85057.5) and non-binding recommendations to further the state's coequal goals for the Delta. DSC does not exercise direct review and approval over covered actions. Covered actions are plans, programs, or projects that (1) will occur, in whole or in part, within the boundaries of the Delta or Suisun Marsh; (2) will be carried out, approved, or funded by the state or a local public agency; and (3) is covered by one or more of the Delta Plan policy areas (reliable water supply; delta ecosystem restoration; water quality improvement; flood risk reduction; and, protection and enhancement of the Delta as an evolving place).

The Delta Plan will be implemented through requiring the statutorily defined covered actions of other public agencies to be consistent with the Delta Plan and providing recommendations to other public agencies regarding future actions they may take. While the State Water Board's regulatory actions are not covered actions subject to the Delta Plan, the Delta Plan contains recommendations for State Water Board's development of flow objectives and criteria for the Delta and major tributary streams in the Delta watershed. The State Water Board identified the Stanislaus, Tuolumne, and Merced Rivers as high priority tributaries for these actions. While the Delta Plan could result in other agencies or entities taking future actions, it would not directly result in regulatory approvals or actions, or other projects. The EIR for the Delta Plan explains that it evaluates potential actions as part of its proposed project, even though the Delta Plan would not directly cause, and the DSC would not have regulatory authority over, most actions (Delta Stewardship Council 2013).

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Flooding, sediment, and erosion
- Agricultural resources
- Energy and greenhouse gases

While the Delta Plan would not directly result in regulatory approvals, actions, or other projects, it could result in other agencies or entities taking future actions. The Delta Plan could recommend and require consistency determinations for projects that could affect circulations patterns in the southern Delta. These projects could reduce circulation of water in the southern Delta, which could reduce dilution of locally saline water and increase salinity in the southern Delta channels. This could increase the number of months with EC above the water quality objective for salinity at the southern Delta compliance locations, thereby potentially affecting the surface hydrology and water quality resources. Additionally, if the Delta Plan recommends projects that involve habitat restoration or flow augmentation, it could have a cumulative effect on flooding, sediment, and erosion. Or, if the Delta Plan recommends projects that could convert agricultural land to nonagricultural uses (e.g., habitat restoration), it could have a cumulative effect on agricultural resources. Lastly, construction of projects recommended by the Delta Plan could rely on considerable use of heavy equipment and construction vehicle trips, which could lead to increased GHG emissions and could have an effect on energy and greenhouse gases.

Project: **Federal Energy Regulatory Commission (FERC) Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)**

Status: Future—project development is ongoing

Location: Tuolumne County, Tuolumne River

Project description: This project would relicense the Don Pedro Hydroelectric Project so it can continue to operate under new license conditions. The current FERC license expired on April 30, 2016. Modesto and Turlock Irrigation Districts filed their application for a new license on April 28, 2014. FERC relicensing of the New Don Pedro Project may affect the operations of the CCSF's Hetch Hetchy system if CCSF contributes water supply to meet instream flows imposed as a condition of water quality certification associated with the relicensing or otherwise imposed through the relicensing process. Currently, however, there is no specific action to alter Hetch Hetchy operations. Some studies remain to be completed before agencies and other stakeholders can file recommended terms and conditions with FERC. State Water Board staff are engaged in the FERC process and will provide input at the appropriate time regarding new streamflow recommendations and other measures for the projection of beneficial uses in the Tuolumne River. The State Water Board also has mandatory conditioning authority due to the required water quality certification under Clean Water Act (CWA) Section 401.

Resource areas with potential cumulative effects:

- Flooding, sediment, and erosion
- Aquatic biological resources
- Terrestrial biological resources
- Recreation resources and aesthetics
- Agricultural resources
- Cultural resources
- Energy and greenhouse gases

The operation of this project was considered in the effects analysis for the LSJR alternatives, including a wide range of potential flow releases. As such, the cumulative effects for the resources listed above are not expected to be significantly different from those identified for the LSJR and SDWQ alternatives, as discussed in the respective resource chapters (Chapters 5–14). However, localized changes resulting principally from re-operation of the reservoir could occur as other agencies have mandatory conditioning authority and because there could be project-specific operational and infrastructure changes. While there are currently no specific action to alter Hetch Hetchy operations any change in CCSF's operations could result in potential cumulative effects to the resources listed above. Localized changes at Don Pedro Reservoir or upstream within the CCSF systems could have a related effects as the plan amendments on the resource areas listed above.

Project: **FERC Relicensing of Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)**

Status: Future—project development is ongoing

Location: Mariposa County, Merced River

Project description: This project would relicense the Merced River and Merced Falls hydroelectric projects (owned by Merced Irrigation District [ID] and Pacific Gas and Electric Company [PG&E], respectively) so they can continue to operate under new license conditions. The original licenses for both projects expired on February 28, 2014. However, both projects continue to operate under FERC-issued annual licenses, which include the conditions of the original licenses, until the relicensing proceedings are completed and new licenses are issued. The participants in the FERC relicensing process filed recommended terms and conditions for inclusion in a new FERC license, and FERC issued a draft EIS for the relicensing of the Merced River Project and the Merced Falls Project on March 30, 2015. Comments on the draft EIS were due to FERC on May 29, 2015 and FERC will address those comments in a final EIS. Merced ID has begun the process to purchase the Merced Falls Hydroelectric Project from PG&E, and so will be the licensee for both projects.

Resource areas with potential cumulative effects:

- Flooding, sediment, and erosion
- Aquatic biological resources
- Terrestrial biological resources
- Recreation resources and aesthetics
- Agricultural resources
- Cultural resources
- Energy and greenhouse gases

The operation of this project was considered in the effects analysis for the LSJR alternatives, including a wide range of potential flow releases. As such, the cumulative effects for the resources listed above are not expected to be significantly different from those identified for the LSJR and SDWQ alternatives, as discussed in the respective resource chapters (Chapters 5–14). However, localized changes resulting principally from re-operation of the reservoir could occur as other agencies have mandatory conditioning authority and because there could be project-specific operational and infrastructure changes. These localized changes could have related effects as the plan amendments on the resource areas listed above.

Project: **FERC Relicensing of Lyons Reservoir**

Status: Planned/ongoing

Location: Upper Stanislaus River (south fork)

Project description: This project would relicense the Lyons Reservoir Hydroelectric Project and allow PG&E continued operation under the facility under new license conditions. The current FERC license expires in August of 2022. PG&E will begin the FERC relicensing process around August of 2017 with their final license application due in the summer of 2020. Studies of the reservoir and system (including the transfer of water to Tuolumne Utilities District (TUD) via the Main Tuolumne Canal to a penstock that connects to PG&E's Phoenix Powerhouse; between 4 to 30 cfs is regularly passed through the powerhouse and discharged to Power Creek) remain to be completed before agencies and other stakeholders can file recommended terms and conditions with FERC. State Water Board staff will be engaged in the FERC process and will provide input at the appropriate time regarding new streamflow recommendations and other measures for the projection of beneficial uses in the Stanislaus River. The State Water Board also has mandatory conditioning authority due to the required water quality certification under CWA Section 401.

Resource areas with potential cumulative effects:

- Aquatic biological resources
- Terrestrial biological resources

- Cultural resources
- Recreation resources and aesthetics
- Cultural resources
- Hydropower
- Energy and greenhouse gases

Localized changes resulting principally from re-operation of the reservoir could occur as other agencies have mandatory conditioning authority and because there could be project-specific operational and infrastructure changes. Localized changes at Lyons Reservoir could have related effects as the plan amendments on the resource areas listed above.

Project: Groundwater recharge projects

Status: Ongoing

Location: Eastern San Joaquin, Modesto, Turlock, and Merced Groundwater Subbasins

Project description: These projects are intended to replenish groundwater resources to prevent or minimize groundwater overdraft and subsidence issues, and are used as part of a conjunctive management approach to ensure a reliable, drought-tolerant regional water supply by banking water in wet years for use in dry years. An example of a groundwater recharge project is the Farmington Groundwater Recharge Program in San Joaquin County. The Stockton East Water District (SEWD), United States Army Corps of Engineers, and other local water agencies launches the project to partner with local landowners, businesses, growers, and ranchers to save the region's water supply by recharging an average of 35 thousand acre-feet (TAF) of water annually into the Eastern San Joaquin Subbasin, in the eastern part of San Joaquin County. The goal of the program is to directly recharge the groundwater basin and increase surface water deliveries in-lieu of groundwater pumping to reduce overdraft and establish a barrier to saline water intrusion.

Resource areas with potential cumulative effect:

- Surface hydrology and water quality
- Aquatic biological resources
- Agricultural resources

Water diverted from the Stanislaus, Tuolumne, and Merced Rivers and the SJR upstream of Merced for these projects could result in decreased inflow of low salinity water into the southern Delta, possibly resulting in higher concentration of pollutants in the SJR and increased salinity in the southern Delta. These projects could also reduce the quality and quantity of water that remains in the rivers and is available for agriculture irrigation, and therefore could have related effects as the plan amendments on surface hydrology and water quality, aquatic biological resources, and agricultural resources. However, as discussed in Chapter 7, *Aquatic Biological Resources*, stream flows are expected to remain within the historic range.

Project: Habitat restoration projects

Status: Planned/ongoing

Location: Merced, Stanislaus, and Tuolumne Watersheds

Project description: Habitat restoration projects may address aquatic habitat (e.g., the Habitat Restoration Plan for the Lower Tuolumne River Corridor and the Gravel Mining Reach Floodway Restoration Projects), or terrestrial habitat (e.g., the Grayson River Ranch Conservation Easement). Restoration projects may include (1) physical activities to address gravel-dominated reaches of the tributaries, where past in-channel and channel-adjacent gravel mining have simplified the channel configuration and aquatic habitat and reduced gravel transport; or (2) re-establishing native plant species and restoring floodplains. Projects considered are as follows.

- Central Valley Project Improvement Act—Mandate to balance competing demands for a limited supply of water, which include: meeting the requirements of fish and wildlife protection, restoration and enhancement; agriculture; and municipal, industrial, and power uses. The 1992 legislation includes mandates that change the management of the CVP and measures that are likely to reduce the amount of water available for irrigation and municipal use. Continued implementation actions include habitat restoration actions in the plan area.
- California EcoRestore (A California Natural Resources Agency initiative)—Help coordinate and advance habitat restoration in the Sacramento–San Joaquin Delta. A broad range of habitat restoration projects will be pursued, including projects to address aquatic, sub-tidal, tidal, riparian, floodplain, and upland ecosystem needs.
- Dos Rios Ranch—Restore land to provide wildlife habitat and flood control in Central Valley on 1,600 acres of biologically rich floodplain in the Central Valley, including along the SJR and Tuolumne River.
- Gravel Mining Reach Floodway Restoration—Restore 7 miles of Tuolumne River actively gravel mined area to increase floodway capacity to convey 15,000 cfs, increase salmon spawning and rearing habitat, protect dikes and off-channel pits from future flood damage, and restore riparian forests on floodplains.
- Habitat Restoration Plan for the Lower Tuolumne River Corridor—Provide an integrated and long-term restoration strategy for the Lower Tuolumne River to maximize anadromous fish habitat improvements, minimize channel restoration project costs, and streamline project evaluation and monitoring. The plan's development process is intended to (1) propose general types of inventoried preservation and restoration sites, (2) evaluate fluvial geomorphic processes, (3) evaluate geomorphic-salmonid relationships and develop restoration strategy, (4) finalize restoration site list and designs, and (5) integrate into a comprehensive river corridor habitat restoration plan.

  Knights Ferry Floodplain and Side-Channel Restoration—Restore existing side-channel and floodplain habitat to benefit Chinook salmon and steelhead.
- Lower Tuolumne River Big Bend Project—Improve forest, river, and wildlife habitats along the Tuolumne River. When completed, over 25,000 native trees and shrubs will have been planted, and over 150 acres of native grasses and forbs will have been seeded throughout the 240,250-acre project area.
- Restoration of the Ruddy Mining Reach—Restore and increase salmonid spawning and rearing habitat along the lower Tuolumne River in the Ruddy Mining area. The project covers a 6.1-mile length of channel and is located approximately 23 miles east of Modesto.
- Proposed Expansion of the San Joaquin River National Wildlife Refuge—Expand the refuge and acquire up to 22,156 acres along the LSJR and Tuolumne and Stanislaus Rivers to protect and restore riparian habitat to benefit the birds of the Pacific Flyway and numerous other wildlife species.

- Spawning Gravel Supplementation (Stanislaus County, Tuolumne River)—Mechanically place large volumes of gravel followed by periodic augmentation and maintenance of gravel supply, as needed, for river restoration.
- Tuolumne River Restoration Projects including Warner Deardorff Segment, Mining Reach Project No. 3—Return a 6.1-mile reach of the Tuolumne River to a more natural, dynamic channel morphology to improve, restore, and protect instream and riparian habitat for fall-run Chinook salmon survival, including restoring hydrological and geomorphic processes.

Resource areas with potential cumulative effects:

- Flooding, sediment, and erosion
- Terrestrial biological resources
- Agricultural resources

Habitat restoration projects are typically not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential. However, if the projects involve construction in or adjacent to channels, the projects may alter the course of a stream or river such that substantial erosion or siltation on- or offsite may result. Additionally, habitat restoration projects typically not expected to result in an impact on terrestrial biological resources as they are meant to recover wildlife species and habitat. However, projects may have short-term impacts (e.g., construction noise or temporary removal of habitat) on sensitive terrestrial species and habitat. Habitat restoration projects could reduce water availability from the Stanislaus, Tuolumne, and Merced Rivers and the SJR, which could reduce the number of irrigated acres, thereby potentially resulting in related effects as the plan amendments on agricultural resources.

Project: Merced County's Castle Airport Master Plan (AMP) for Development of Castle Airport

Status: Future—project development is ongoing

Location: Merced County

Project description: Adopted by Merced County in 2011, the AMP lays out the plan for ultimate development of the airport and its operations. The project would convert the former U.S. Air Force base into a civilian use airport that would include an air cargo facility, a corporate and private aircraft service center, a charger operation, modern hangers, and a cold storage facility for produce. The AMP functions as a tool for the implementation of the aviation elements, and is consistent with the planned airport facilities and operations are specified in the 1996 Castle Air Force Base Reuse Plan. The completed project would include office and commercial development, and is expected to promote new jobs to area residents, air cargo and airline operations, stimulate investment and new growth, and create employment opportunities and commercial development. The project's initial study found that this project would result in increased water demand and is likely to deplete groundwater supplies (County of Merced Department of Commerce 2011).

Resource areas with potential cumulative effects:

- Groundwater resources
- Service providers
- Energy and greenhouse gases

This project is expected to encourage population growth, which could increase water use in the region, which has historically relied on groundwater supplies. Increased water demand could increase groundwater pumping, thereby affecting groundwater resources and the service providers who would need to meet the increased water demand. Additionally, this project could have construction-related impacts that could lead to increased GHG emissions. Thus, the project could have related effects as the plan amendments on groundwater, service providers, and energy and greenhouse gases.

Project: Modesto Regional Water Treatment Plant (MRWTP) Phase Two Expansion Project

Status: Ongoing

Location: Tuolumne River and SJR Watersheds in Stanislaus County

Project description: The Modesto Irrigation District (MID) and the City of Modesto expansion of the City's water treatment plant doubles the plant's capacity. The project also involves the construction of multiple downstream facilities (including storage reservoirs, pump stations, transmission and distribution pipelines, and regulating values) to provide adequate municipal and industrial water supply within the City's service area. The project is intended to ensure reliable water supplies, and meet increased water demands associated with projected population growth in the region. Lastly, the project's Final Subsequent Environmental Impact Report states that the City of Modesto is also building additional water supply wells to make up for well capacity that has been lost due to contamination (MID 2005).

Resource areas with potential cumulative effects:

- Groundwater resources
- Agricultural resources
- Energy and greenhouse gases

This project would improve the quality of drinking water sources and therefore would not result in cumulatively considerable or significant effects on service providers. This project is partially in response to projected population growth and the associated increases in total water use demands. As this area has historically relied on groundwater supplies, increased water demand could increase groundwater pumping, thereby affecting groundwater resources. Increasing the plant's capacity allows the City to receive more water for domestic use, which could result in reduced water availability for agricultural uses, thereby reducing the number of acres that could be irrigated. Additionally, this project could have construction-related impacts that could lead to increased GHG emissions. Thus, the project could have related effects as the plan amendments on groundwater, agricultural resources, and energy and greenhouse gases.

Project: NMFS Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP

Status: Present

Location: SJR, tributaries, southern Delta, Delta

Project description: A 2009 BO in which NMFS concluded that continued operations of the CVP and SWP would likely jeopardize several listed species, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, the southern distinct population segment of North American green sturgeon, and southern resident killer whales. The 2009 BO identifies the following actions to be taken by USBR and/or DWR.

- Limit the magnitude of reverse flows in Old and New Rivers to reduce entrainment of juvenile fish into state and federal export facilities in the southern Delta.
- Implement facility improvements at state and federal export facilities to increase fish survival.
- Implement measures, including a fish study using acoustic tags, to increase survival of juvenile steelhead migrating from the SJR Basin.
- Implement a year-round minimum flow regime that improves conditions for steelhead in the Stanislaus River.
- Issue a BO effective through December 31, 2030.
- Propose a reasonable and prudent alternative (RPA) that, if implemented, is believed to avoid the likelihood of jeopardizing the continued existence of these listed species.

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Aquatic biological resources
- Terrestrial biological resources
- Agricultural resources
- Cultural resources
- Energy and greenhouse gases

This project places limits on SWP and CVP exports and reverse flows on Old and Middle Rivers. These changes to hydrodynamics in the Delta, including limits on Old and Middle River flows, could affect circulation patterns in the southern Delta and could result in different salinity conditions in the southern Delta. Through elevated salinity levels in the southern Delta, the ongoing project, therefore, has the potential to have a cumulative effect on surface hydrology and water quality, aquatic biological resources, terrestrial biological resources, and agricultural resources. Additionally, this project could result in the re-operation of the reservoirs which could lead to a change in the amount and timing of water surface elevation fluctuations in the reservoirs. A change in the rates of flows downstream of the reservoirs could have a cumulative effect on the cultural resources. These changes could also change the timing of, or reduce, hydropower generation from the dams, which, in turn, could have an effect on energy resources.

Project: Recreation management and improvement projects

Status: Planned/ongoing

Location: Merced, Stanislaus, and Tuolumne Watersheds, and SJR up to Friant Dam

Project description: These long-term management plans implement projects to improve and increase recreation facilities and establish a visitor use capacity program that addresses the kinds and amounts of public use that can be sustained while protecting and enhancing the resource. Projects considered include the following.

- Tuolumne Wild and Scenic River Comprehensive Management Plan—Long-term management plan for the 54-mile stretch of the Tuolumne Wild and Scenic River corridor within Yosemite National Park to ensure a high-quality visitor experience. The plan includes projects that would expand recreational opportunities in the riparian zone and improve conditions that pose localized risks to scenic vistas. Located within the extended plan area.
- Merced Wild and Scenic River Final Comprehensive Management Plan—Long-term management plan for the Merced River corridor to ensure a high-quality visitor experience. The plan includes projects that would increase camping opportunities, diversity recreation options, and restore the riverbank, which would improve in-water recreation activities. Located within the extended plan area.
- Central Valley Vision—A 20-year roadmap for improving state parks in the Central Valley. Includes improving and increasing recreation facilities at existing parks (e.g., new boating trails, increasing the number of campsites and picnic sites, and improving river access for swimming, boating, and other water sports) along the Stanislaus, Merced, and Tuolumne Rivers and the SJR.
- San Joaquin River Blueway Plan—A plan that provides the public opportunities to explore and enjoy the SJR from its headwaters to the Delta via a network of parks, wildlife refuges, and other publicly accessible places. The long-term vision plan, released in 2011, proposes improved access to the Upper SJR by creating a blueway—a boating trail to camping, fishing, bird watching, and other kinds of recreation. The plan would provide additional shore-based recreation opportunities, which may result in increased opportunities for water-enhanced recreation. The plan would expand recreational opportunities and use of the SJR without degrading the condition or visual character of the resource.

Resource areas with potential cumulative effects:

- Recreation resources and aesthetics

These types of projects are typically not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential. And, unrelated to flow and water levels, these and similar projects would be expected to modify and enhance on-bank and in-water recreational opportunities. However, the development of recreation facilities around the reservoirs and urbanization of the watersheds could impact the views and viewsheds (i.e., aesthetics) experienced by recreationists. Thus, the projects could have related effects as the plan amendments on recreation resources and aesthetics.

Project: San Francisco Public Utilities Commission (SFPUC) Hetch Hetchy Repair and Rehabilitation Program and Lower Cherry Aqueduct Emergency Rehabilitation

Status: Present

Location: Tuolumne River and Lower Cherry Aqueduct

Project description: The Lower Cherry Aqueduct (LCA) consists of a small diversion dam on Cherry Creek and a 3.6-mile-long aqueduct comprised of alternating segments of tunnel, canal, and above-ground and buried pipelines that convey water from Cherry Creek Diversion Dam (CCDD) to Early Intake Reservoir on the Tuolumne River. At Early Intake Reservoir, Mountain Tunnel head gates can be opened to allow water to flow into the SFPUC's tunnel and pipeline system that carries water to the San Francisco Bay Area. The reliable function of this facility is critical for providing a backup water supply for SFPUC customers. The proposed improvements, to be implemented in two phases, would initially replace open canal sections with large-diameter buried pipe; restore and replace deteriorated fire-damage structures at CCDD, and restore the access path to the CCDD. In the future, one section of elevated pipeline that constricts the flow of the aqueduct would be replaced with a larger-diameter pipeline to restore the facility's historical design capacity of 200 cfs.

Resource areas with potential cumulative effects:

- Aquatic biological resources
- Terrestrial biological resources

Streamflows within Eleanor and Cherry Creeks would be directly affected by operation of LCA. Operation of the LCA also would have an indirect streamflow effect within Cherry Creek downstream of Holm Powerhouse and on the mainstem of the Tuolumne River during reservoir storage recovery years. As such, implementation could have an effect on habitat conditions for aquatic and biological species.

Project: Sustainable Groundwater Management Act (SGMA)

Status: Present

Location: Groundwater basins underlying the LSJR, Delta, and tributaries

Project description: SGMA establishes a framework requiring local agencies to sustainably manage groundwater resources. SGMA imposes deadlines for local agencies to form groundwater sustainability agencies, draft groundwater sustainability plans, and implement those plans to achieve groundwater sustainability within 20 years of plan adoption. SGMA authorizes state intervention in groundwater basin management if local managers are unable or unwilling to meet SGMA requirements. Given the directive to local agencies, and the backstop of state intervention if needed, it is anticipated that SGMA, along with other groundwater recharge, conjunctive use, and management projects, would not adversely impact groundwater resources and would actually benefit groundwater resources.

Resource areas with potential cumulative effects:

- Agricultural resources

SGMA would improve groundwater resources and provide service providers tools to prevent and/or mitigate domestic well drinking water supply impacts and therefore are not expected to result in a cumulative impact on groundwater resources and service providers. However, the initial implementation of SGMA could result in limits on groundwater supply for agricultural uses during the transition from current practices to sustainable groundwater management and, thus, could affect agricultural resources. Therefore, implementation of SGMA could potentially have a cumulative effect on agricultural resources.

Project: Tuolumne Utilities District (TUD) Phoenix Lake Preservation and Restoration Project

Status: Present and Future, -On-going Phased Project

Location: Tuolumne River, Tuolumne County

Project description: Phoenix Lake is an 88-acre water storage reservoir located approximately 3 miles east of the City of Sonora. Phoenix Lake water rights and facilities, as well as portions of the lake, are owned by the TUD. The TUD uses the lake as a primary drinking water source for the communities of Sonora, Jamestown, Scenic View and Mono Village. While the allowable storage capacity of the lake is approximately 900 acre-feet (AF), the current capacity is only 600 AF.

Phase III project will improve the water quality and restore storage capacity in Phoenix Lake and the Phoenix Lake watershed. Phase III will provide access to approximately 170 AF of water that currently does not exist. The construction of the sediment forebay will remove a majority of the sediments transported to the lake via the Sullivan Creek watershed.

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Aquatic biological resources
- Terrestrial biological resources
- Recreational resources and aesthetics
- Cultural resources
- Energy and greenhouse gases

Depending on the historical diversions of TUD, the diversions could increase by up to 170 AF, given that Phase III would increase storage capacity up to that amount. This diversion could occur during the summer when water is typically used by TUD. As such, the on-going project also has the potential to have a cumulative effect on aquatic biological resources in the reservoir, terrestrial biological resources around the reservoir, and recreational resources and aesthetics in and around the reservoir depending on the drawdown experienced by the reservoir under the new storage capacity. The project is intended to improve water quality conditions in the lake and the long term health of the lake and its storage capacity, and as such is expected to have a beneficial effect on surface hydrology and water quality.

Project: USFWS Biological Opinion on the Long-Term Operations of CVP and SWP (delta smelt)

Status: Present

Location: SJR, tributaries, southern Delta, Delta

Project description: USFWS issued an opinion on December 15, 2008, to USBR on the effects of the continued operation of CVP and SWP on delta smelt and its designated critical habitat. It identified an RPA intended to protect each life stage and the critical habitat of the federally protected delta smelt and its designated critical habitat that includes flow components.

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Aquatic biological resources
- Agricultural resources

This project places limits on SWP and CVP exports and reverse flows on Old and Middle Rivers. The NMSF biological opinion is meant to protect fish listed under ESA from being jeopardized by the adverse effects of SWP and CVP export water operations. While the required reservoir releases and pumping reductions could reduce direct impacts on fish, thereby not resulting in an impact on aquatic biological resources, less Sacramento River water could be drawn into the southern Delta, which could increase salinity. These changes to hydrodynamics in the Delta, including limits on Old and Middle River flows, could affect circulation patterns in the southern Delta resulting in different salinity conditions in the southern Delta. Through elevated salinity levels in the southern Delta, the on-going project also has the potential to have a cumulative effect the surface hydrology and water quality, and agricultural resources.

Project: University of California (UC) Merced 2020 Project

Status: Future—project development is ongoing

Location: Merced County

Project description: The project will double the size of the UC Merced campus to accommodate up to 10,000 students by 2020. The project would add approximately 1.2 million gross square feet of classroom, laboratory, student life, housing, and administrative and faculty space on 219 acres, including 136 acres of undeveloped land adjacent to the existing campus.

Resource areas with potential cumulative effects:

- Groundwater resources
- Service providers
- Energy and greenhouse gases

This project is expected to encourage population growth, which could increase water use in the region, which has historically relied on groundwater supplies. Therefore, it can be presumed increased water demand could increase groundwater pumping, thereby affecting groundwater resources and the service providers who would need to meet the increased water demand. Additionally, although the completed project is expected to reduce GHG emissions, the construction of the project would rely on considerable use of heavy equipment and construction vehicle trips, which could lead to increased GHG emissions. Thus, the project could have related effects as the plan amendments on groundwater, service providers, and energy and greenhouse gases.

Project: Update to the 2006 Bay-Delta Plan, Phase II

Status: Future—project development is ongoing

Location: Delta

Project Description: The comprehensive update of the 2006 *Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan) by the State Water Board will evaluate and potentially amending existing water quality objectives that protect beneficial uses and the program of implementation to achieve those objectives. The elements of the Phase II update are: (1) Delta outflow objectives, (2) export/inflow objectives, (3) Delta Cross Channel Gate closure objectives, (4) Suisun Marsh objectives, (5) potential new reverse flow objectives for Old and Middle Rivers, (6) potential new floodplain habitat flow objectives, (7) potential changes to the monitoring and special studies program, and (8) other potential changes to the program of implementation. The State Water Board will also consider other potential changes to the Bay-Delta Plan during Phase II, including issues identified through the scoping process and information that is produced as part of California WaterFix.

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Aquatic biological resources

- Agricultural resources
- Service providers

The principal elements of the Phase II update that could have potential cumulative effects are changes in export/inflow objectives and reverse flow objectives for Old and Middle River. The export/inflow objectives could change the timing and magnitude of exports from SWP and CVP pumping facilities, and other diversions, in the southern Delta in order to protect migrating salmon and other species. New reverse flow objectives for Old and Middle River could affect the quantity and timing of high quality Sacramento River flows across the Delta from the Sacramento River to the SWP and CVP export facilities in the southern Delta. Both of these elements have the potential to change salinity conditions, including elevated salinity, in the southern Delta, which could have a cumulative effect on surface hydrology and water quality. Elevated salinity in the southern Delta channels would reduce assimilative capacity in southern Delta channels, and that could have an effect on aquatic biological resources, agricultural resources, and service providers.

Project: Upper San Joaquin River Restoration Program (SJRRP), including Water Year 2010 Interim Flows Project

Status: Present

Location: Fresno and Madera Counties, Upper SJR

Project description: This program is a comprehensive long-term effort to restore flows to the SJR from Friant Dam to the confluence of Merced River and restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply impacts from restoration flows. The first water releases from Friant Dam in support of the SJRRP, called interim flows, began October 1, 2009. Restoration flows began January 1, 2014. The program includes provisions to reduce or avoid water supply impacts by recapturing water. This element of the program may include modifications to existing facilities or the construction of new facilities to deliver water directly back to the Friant Division Contractors, or may be made available to others through transfers, exchanges or sales. This may include operational changes and the construction of facilities in the LSJR and the Delta.

Resource areas with potential cumulative effects:

- Flooding, erosion, and sediment
- Aquatic biological resources

This project will increase flows in the SJR upstream of the plan area, and so it has the potential to improve conditions for fish and increase groundwater recharge in the southeastern boundary of the plan area. To the extent that any of the flows continue downstream of the Merced River confluence, the project has the potential to increase LSJR flows, thus benefitting fish and wildlife. Most of the potential effects of the project occur in areas that have not recently had any flow in most years. These areas are in the LSJR upstream of the Merced River confluence and are outside of the plan area. While there is potential for the project to result in flooding and seepage effects in the SJR and have effects on terrestrial, recreational, and agricultural resources, these effects would occur outside the plan area. To the extent that the Upper SJRRP flows contribute to increased flows in the LSJR at and below the Merced River confluence, the project could increase the movement of contaminants into the LSJR and affect temperatures. Thus, there is a potential for a cumulative significant effect on aquatic biological resources.

Environmental documents prepared for the project identify that there could be increases of temperature in the SJR downstream of the Merced River, but these are at times of very low Merced River flows. The LSJR alternatives would increase Merced River flows overall, thus reducing any such temperature effect. The Upper SJRRP environmental documents conclude that surface water effects in the SJR from the Merced River to the Delta would be less than significant and that there would be a less-than-significant effect on fall-run Chinook salmon and other native fishes in the Stanislaus, Tuolumne, and Merced Rivers. The adaptive implementation element of the LSJR alternatives allows the timing of flows to be optimized to

achieve the flow objectives while allowing for consideration of other beneficial uses, thus further reducing or eliminating any possible temperature effect.

Project: Water transfers

Status: Future

Location: Sacramento River and SJR Watersheds

Project description: Water transfers are likely to occur in the future and may involve transfers of water between entities within the project area, transfers from outside the project area to users within the project area, or transfers from entities within the project area to users outside the project area. Water transfers would occur beyond those that would occur in response the LSJR alternatives. Water transfers that involve changes in point of diversion, place of use, or purpose of use to a post-1914 water right most often require the approval of the State Water Board. Transfers of water between CVP contractors or SWP contractors do not require action by the State Water Board unless the point of diversion, purpose of use, or place of use under the CVP's or SWP's water right needs to be changed to accomplish the transfer. Transfers that require the use of state, regional, or a local public agency's conveyance facilities require the owner of the conveyance facilities (e.g., DWR, USBR) to determine that the transfers will not harm any other legal user of water, will not unreasonably affect fish and wildlife, and will not unreasonably affect the overall economy of the county from which the water is transferred. The most common forms of water transfers involve reservoir reoperation, substitution of groundwater for surface water, and crop acreage idling.

Resource areas with potential cumulative effects:

- Surface hydrology and water quality
- Flooding, sediment, and erosion
- Aquatic biological resources
- Terrestrial biological resources
- Groundwater resources
- Recreational resources and aesthetics
- Agricultural resources
- Energy and Greenhouse Gases

Water transfers have the potential to change or increase flows, which could alter the hydrodynamics in the southern Delta, and could have a cumulative effect on surface hydrology and water quality. Because any increases in flows resulting from the transfers would be well within normal channel capacities, water transfers are typically not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential. However, transfers that include a flow shifting component could reduce flows outside the transfer period and could result in reduced surface water availability, both of which could have a cumulative effect on aquatic biological resources; terrestrial biological resources; groundwater resources; and agricultural resources. Energy and greenhouse gases could also be affected if reservoir releases are substantially changed such that hydropower is not produced when it may be needed. Lastly, transfers could alter reservoir levels, which could have an impact on recreational resources and aesthetics. As such, transfers could have an effect on the resource areas listed above.

Projects with No Potential Cumulative Impacts

In considering other projects that may contribute to related impacts in combination with the LSJR and SDWQ alternatives, this SED identified categories of projects that may have beneficial impacts on environmental resources, or would otherwise not have related adverse effects and are, therefore, not expected to contribute to significant cumulative impacts. This section identifies such categories of projects.

Projects with Beneficial Effects

Some projects will generally improve water quality conditions, and have a beneficial effect on surface hydrology and water quality in the plan area. As such, these projects are not expected to contribute to significant adverse effects in the plan area or extended plan area. Examples of such projects include the following.

- Agricultural Drainage Selenium Management Program—Reduce agricultural drainage containing elevated levels of selenium (through land and irrigation management practices) and limit where and when drainage water can be discharged.
- Conditional Waiver of Waste Discharge Requirements for Irrigated Lands—Central Valley Regional Water Quality Control Board (Central Valley Water Board) will use conditional waivers to develop new and additional information to establish a more reasonable basis for adoption of individual or general waste discharge requirements in the future. A conditional waiver is a regulatory process under California's nonpoint source program designed to meet requirements of the California Water Code. Discharges from irrigated agricultural lands are regulated to prevent the agricultural discharges from impairing the waters that receive the discharges.
- Grasslands Bypass Project (U.S. Bureau of Reclamation [USBR] and San Luis Delta Mendota Water Authority discharges of salt, selenium, and boron)—This project in Merced and Fresno Counties prevents discharge of subsurface agricultural drainage water into wildlife refuges and wetlands in central California and reduces the discharge of selenium, boron, and salt into the SJR.
- Tuolumne Utilities District (TUD) Phoenix Lake Preservation and Restoration Project—The project is intended to improve water quality conditions in the lake and the long-term health of the lake and its storage capacity by removing sediment and creating a sediment forebay and, as such, is expected to have a beneficial cumulative effect on surface hydrology and water quality.

Some projects will generally improve water supply conditions and have a beneficial effect on the surface hydrology and water quality and groundwater resources in the plan area. As such, these projects are not expected to contribute to significant effects in the plan area. Examples of such projects include the following.

- Bay Area Water Quality and Supply Reliability Program—This program identifies regional opportunities for the participating Bay Area water agencies to improve water supply and water quality for the benefit of the entire Bay Area.
- City of Stockton Delta Water Supply Project (DWSP)—Completed in 2012, this project pumps water from the Delta through miles of underground pipeline, along Eight Mile Road to a surface water treatment plant, to provide a new supplemental, high-quality water supply for Stockton.

- City of Tracy Connection to the South San Joaquin Irrigation District (SSJID)—Completed in 2009, the City of Tracy's second connection to the SSJID water line allows the City to receive additional potable water.
- Eastern San Joaquin Integrated Conjunctive Use (ICU) Program—This project would develop approximately 140–160 TAF per year of new surface water supply for the basin to directly and indirectly support conjunctive use by Northeastern San Joaquin County Groundwater Banking Authority (GBA) member agencies. This amount of water would support groundwater recharge consistent with the GBA's objectives for conjunctive use and the underlying groundwater basin. The GBA approved the ICU Program in February, 2011.
- New Exchequer Spillway Modification—This project on the Merced River would increase the height of the existing spillway gates and un-gated spillway by 8 to 10 feet, which would increase the storage capacity of Lake McClure.

Projects with No Significant Adverse Effects

Certain plans and policies like the California Water Plan establish policy and direction for the management of the state's water resources. As discussed below, the plan would not result in environmental effects and, therefore, would not contribute to any cumulative effects.

- California Water Plan—This strategic plan for managing and developing the state's water resources provides a planning framework for water managers, elected officials, agencies, tribes, businesses, stakeholders, and the public to develop findings and recommendations and make decisions regarding California's water future. The water plan is updated every 5 years.
  The water plan does not mandate action or authorize spending for actions. It also does not include environmental review and documentation as would be required under CEQA. Because the water plan does not cause environmental impacts, it would not contribute to cumulative effects.

17.2.2 Cumulative Impact Analysis

This section describes, analyzes, and determines the potential cumulative impacts of the LSJR and SDWQ alternatives within the plan area, as appropriate for each resource area, which could result from the implementation of the proposed plan amendments and the projects summarized in Table 17-1. This section also describes, analyzes, and determines the potential cumulative impacts of the LSJR alternatives in the extended plan area, as appropriate for each resource area. As discussed previously, the SDWQ alternatives would not have impacts in the extended plan area because (1) flows in the extended plan area are not expected to change in response to the SDWQ alternatives, and (2) the extended plan area is far upstream from the southern Delta, which means that any change in the salinity conditions in the southern Delta would not affect the water quality in the extended plan area. As such, no cumulative impact is associated with the SDWQ alternatives in the extended plan area and, therefore, the SDWQ alternatives in relation to the extended plan area are not discussed further in this section. The resource areas in this section correspond with the resource chapters (Chapters 5–14) of this SED. As stated above, the cumulative impacts associated with the No Project Alternative (LSJR/SDWQ Alternative 1) are discussed in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*.

Surface Hydrology and Water Quality

As stated in Chapter 5, *Surface Hydrology and Water Quality*, LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3 would have a less-than-significant impact on the surface hydrology and water quality resources in the plan area and extended plan area.

The impacts considered in Chapter 5 are as follows.

- Impact WQ-1: Violate water quality standards by increasing the number of months with electric conductivity (EC) above the water quality objectives for salinity at Vernalis or southern Delta compliance stations
- Impact WQ-2: Substantially degrade water quality by increasing Vernalis or southern Delta salinity (EC) such that agricultural beneficial uses are impaired
- Impact WQ-3: Substantially degrade water quality by increasing pollutant concentrations caused by reduced river flows

Overall, the LSJR alternatives would cause flows to increase, which would reduce pollutant concentrations and improve any current chronic water quality problems. Higher flows would also result in an overall decrease in salinity concentrations in the southern Delta. However, flows would be variable and would sometimes be lower than under baseline. Other projects that could result in cumulative effects have the potential to degrade water quality either through the reduction of dilution flows, changing hydrodynamic conditions in the Delta, or through the addition of pollutants. As discussed in Chapter 5, upstream of the rim dams,[2] river flows would also increase and reduce pollutant concentrations under the LSJR alternatives, and reservoir level changes would not change or increase pollutant concentrations. There would be no cumulative water quality impacts upstream of the rim dams. In the plan area, the SDWQ alternatives would only have an effect on WQ-1 by changing the EC standard, thereby reducing the number of exceedances of the standard. Otherwise, the SDWQ alternatives would have no impact. Therefore, the SDWQ alternatives would not cause a significant cumulative impacts and are not discussed further in this section.

Projects could result in a cumulative effect on water quality if they violate water quality standards by increasing the number of months with salinity (EC) above the water quality objectives for salinity at Vernalis or southern Delta compliance stations (Impact WQ-1) or substantially degrade water quality by increasing Vernalis or southern Delta EC such that agricultural beneficial uses are impaired (Impact WQ-2). Accordingly, with respect to these impacts, the geographic scope of this cumulative analysis focuses on projects within the area comprising Vernalis and the southern Delta and that have the potential to increase EC through the reduction of dilution flows, changes in hydrodynamic conditions in the Delta, or the addition of pollutants elsewhere in the plan area. The geographic scope also includes the Stanislaus, Tuolumne and Merced Rivers in the plan area and the extended plan area because these are the areas where water quality degradation impacts could occur (Impact WQ-3).

EC values in the southern Delta are primarily affected by the salinity of water flowing into the southern Delta from the SJR at Vernalis, salt discharged back into southern Delta channels that was previously diverted for irrigation, the combined CVP and SWP pumping influencing salinity in the

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[2] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

southern Delta, and tidal mixing of inflow from the Pacific Ocean. Municipal treated wastewater discharges have some effect on the southern Delta salinity. The LSJR flow at Vernalis has a large effect on the LSJR salinity at Vernalis. Following a dilution relationship in which salinity is inversely proportional to the flow, higher flows generally reduce salinity. Increased CVP and SWP pumping could also affect southern Delta salinity by bringing more low-salinity Sacramento River water across the Delta to the export pumps. However, periods of low Delta outflow (in the fall months) could cause increased seawater intrusion and higher EC at the southern Delta export intakes for the CVP and SWP.

Past and present cumulative projects that have contributed to elevated salinity in the southern Delta are discussed in more detail in the environmental setting section of Chapter 5. Examples of such projects that affect salinity in the southern Delta include the operation of the SWP and CVP, which alter the hydrodynamics in the southern Delta, development of irrigated agricultural lands, water diversions, and discharges from publicly owned treatment works (POTWs) in the southern Delta and in the LSJR upstream of Vernalis.

In general, future actions that could cumulatively affect water quality in the southern Delta resulting in elevated salinity are similar to the past and present projects and include new water diversions, water transfers, changes to SWP and CVP pumping, and changes to discharges from POTWs and agricultural lands. Past, present, and reasonably foreseeable probable future projects, described in Table 17-1, may have effects on surface hydrology and water quality resources through the following mechanisms.

- Change in circulation patterns in the southern Delta such that the mixture of low and high salinity water changes, resulting in higher salinity in the southern Delta (this is limited to an analysis of projects in the southern Delta).
- Change in flow and salt discharges into the southern Delta (this is limited to projects in the southern Delta and projects in the SJR Watershed that increase salt discharges).
- Degradation of water quality by increasing pollutant concentrations caused by reduced river flows in the plan area.

Projects, described in Table 17-1, that could change circulation patterns in the southern Delta include the following.

- California WaterFix
- Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and Central Valley-wide Salt and Nitrate Management Plan (SNMP)
- Delta Stewardship Council (DSC) Delta Plan
- NMFS BO (for salmon)
- USFWS BO (for delta smelt)
- Update to the 2006 Bay-Delta Water Plan, Phase II

These projects could directly reduce circulation of water in the southern Delta, and thereby reduce dilution of locally saline water, which could result in increased salinity in southern Delta channels. For example, California WaterFix, which calls for the construction of facilities to divert water from the Delta at a location on the Sacramento River, could result in increased salinity in southern Delta channels if less low salinity water is pumped at the existing export facilities in the southern Delta.

Additionally, projects intended to protect endangered species (e.g., salmon and delta smelt) could also increase salinity in the southern Delta. The NMFS BO and the USFWS BO (collectively the "BOs") would place constraints on the future operation of the SWP and CVP and could reduce the quantity of low salinity water pumped across the Delta into the southern Delta, thereby resulting in increased salinity in the southern Delta. Similarly, future updates to the 2006 Bay-Delta Water Plan, Phase II could place conditions on the CVP and SWP that would reduce exports at the facilities operated by the California Department of Water Resources (DWR) and USBR, or other conditions on DWR, USBR, and other water right holders that would change the quantity of low salinity water flowing into southern Delta channels, and thereby increase salinity in the southern Delta. Additionally, although the Delta Plan would not directly result in regulatory approvals, actions, or other projects, it could result in other agencies or entities taking future actions. For example, the Delta Plan could recommend and require consistency determinations for projects that may affect circulations patterns in the southern Delta, thereby indirectly affecting the surface hydrology and water quality resources.

Projects, described in Table 17-1, that change flow and salt discharges into the southern Delta include the following.

- CV-SALTS

As described in Table 17-1, CV-SALTS includes the development of new salinity objectives for the LSJR upstream of Vernalis and a program of implementation to achieve these objectives. It could affect the timing of salt discharges to the LSJR, which could result in increased salinity in the SJR and increased salinity in the southern Delta.

Projects that reduce river flows could result in significant cumulative impacts by substantially degrading water quality by increasing pollutant concentrations caused by reduced river flows (Impact WQ-3). Projects, described in Table 17-1, that could change flow patterns and degrade water quality by increasing pollutant concentrations caused by reduced river flows include the following.

- Groundwater recharge projects
- Water transfers

Groundwater recharge projects would typically operate at times of high flows. However, if they were to operate during relatively low flow periods, the projects could result in lower flows. The resulting decreased inflow of low salinity water into the southern Delta could result in higher concentration of pollutants in the SJR and increased salinity in the southern Delta. While water transfers would tend to increase flows, the transfers could include a flow shifting component that would reduce flows outside the transfer period. In such cases, salinity would be improved as a result of increased low salinity water at the time of the transfer; however, salinity may increase at other times due to lower flows outside of the transfer period. Additionally, wastewater change petitions could result in lower flows during already low flow periods.

Of those projects discussed above where the State Water Resources Control Board (State Water Board) has approval authority (e.g., California WaterFix, WWCPs, and groundwater recharge projects), it would be required to consider and implement water quality objectives for salinity and other pollutants such that objectives are not exceeded. Notwithstanding this, given the condition of the surface hydrology and water quality in the plan area, the impacts of past, present, and reasonably foreseeable probable future projects on water quality are cumulatively significant.

However, the LSJR alternatives would generally increase river flows on the three eastside tributaries, as compared to baseline conditions for February–June, and there are only small changes in flow expected outside of these months. Increases in flow typically result in lower salinity levels, and therefore would not cause an increase in exceedances of existing (or proposed) water quality objectives nor result in an impact on the agricultural beneficial use, as discussed for Impacts WQ-1 and WQ-2, respectively, in Chapter 5. Additionally, as discussed for Impact WQ-3, the general increase in flow would typically result in lower concentrations of pollutants.

Therefore, LSJR Alternative 2, 3, and 4 would not result in a cumulatively considerable[3] incremental contribution to cumulative impacts or significant cumulative impacts related to salinity and water quality degradation, and cumulatively adverse impacts would be less than significant.

In the extended plan area, surface hydrology and water quality would not be degraded and violation of water quality standards would not occur as a result of the LSJR alternatives. As described in Chapter 5, Section 5.4.4*, Impacts and Mitigation Measures: Extended Plan Area,* water quality in the upstream Stanislaus, Tuolumne, and Merced Rivers is generally high quality and there is a relatively small volume of water that could be affected by LSJR Alternatives 2, 3, and 4 in the extended plan area on the three eastside tributaries. In general these alternatives would cause flows to increase, which would reduce concentrations and improve any chronic water quality problems. In addition, upstream reservoirs in the Stanislaus and Tuolumne Watersheds is generally high quality (there are no substantial reservoirs upstream on the Merced River). Furthermore, reservoir volume reductions would have minimal effects on most water quality constituents (e.g., mercury) because the reduction in storage would result from water (and the constituent) flowing out of the reservoir. In other words, the concentrations of water quality constituents would not change or increase relative to baseline and it is unlikely that the water quality would be degraded. Past, present and reasonably foreseeable probable future projects identified in Table 17-1 that could affect surface hydrology and water quality in the extended plan area include the Phoenix Lake Preservation and Restoration Project and the Lyons Reservoir Modification. The Phoenix Lake Preservation and Restoration project is expected to result in an overall benefit to surface hydrology and water quality by controlling and capturing sediment. Therefore, LSJR Alternative 2, 3, and 4 would not result in a cumulatively considerable incremental contribution to cumulative impacts or significant cumulative impacts related to surface hydrology and water quality degradation.

Flooding, Sediment, and Erosion

As stated in Chapter 6, *Flooding, Sediment, and Erosion*, LSJR Alternatives 2, 3, and 4 would have a less-than-significant impact on flooding, sediment, and erosion in the plan area and extended plan area. Under the SDWQ alternatives, salinity would generally remain the same as baseline conditions; furthermore, change in water quality does not affect flooding, sedimentation, or erosion. As such, SDWQ Alternatives 2 and 3 would have no impact on the flooding, sediment, and erosion and, therefore, are not considered further in this section.

The impacts considered in Chapter 6 are as follows.

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[3] *Cumulatively considerable* means that the incremental effects of an individual project are significant when viewed in connection with the effects of past, current, and probably future projects. (Cal. Code Regs., tit 14, § 15065, subd. (a)(3).)

- Impact FLO-1: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or offsite
- Impact FLO-2: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or offsite

The geographic scope of this cumulative analysis focuses on projects within the plan area and the extended plan area since it is where impacts could occur, in addition to the larger SJR Basin, because activities within the larger basin could affect sedimentation and flooding.

The LSJR alternatives would change flow patterns in rivers throughout the plan area and extended plan area. However, the range of flows would be similar to flows that occur under baseline conditions. Therefore, the amount of sediment and gravel transported at higher flows and flows that exceed channel capacities are expected to be similar to baseline conditions.

Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on flooding, sediment, and erosion through the following mechanisms.

- Alteration of drainage patterns, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or offsite.
- Alteration of existing drainage patterns, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding.

Habitat restoration or other projects that involve construction in or adjacent to channels may alter of the course of a stream or river, through changes in floodplain geometry, such that substantial erosion or siltation on- or off-site may occur. Following is a list of such projects, which are described in Table 17-1.

- California EcoRestore
- Central Valley Project Improvement Act projects
- Dos Rios Ranch
- Gravel Mining Reach Floodway Restoration
- Habitat Restoration Plan for the Lower Tuolumne River Corridor
- Knights Ferry Floodplain and Side-Channel Restoration
- Lower Tuolumne River Big Bend Project
- Restoration of the Ruddy Mining Reach
- Spawning Gravel Supplementation (Stanislaus County, Tuolumne River)
- Tuolumne River Restoration projects, including Warner Deardorff Segment—Mining Reach Project No. 3

California EcoRestore will include many smaller habitat restoration projects that are mostly outside the plan area, but some projects may be implemented in the southern Delta portion of the plan area. The Central Valley Improvement Act includes a suite of habitat restoration projects and actions in the Central Valley, including within the plan area. Other projects, such as Dos Rios Ranch, Habitat

Restoration Plan for the Lower Tuolumne River Corridor, Knights Ferry Floodplain and Side-Channel Restoration, and other listed projects, will restore habitat in floodplains, add sinuous reaches similar to natural channels, and add gravel that can be moved by moderate to high flows. These projects could alter the course of water flowing in a river or stream, but the changes would be similar to existing natural channels, as would sedimentation levels. To the extent that these projects occur in floodplains within the plan area, the projects could also have short-term construction-related impacts that could result in erosion. However, these effects would likely be less than significant because the projects would employ standard construction practices (e.g., erosion control and best management practices). Moreover, the floodplain restoration projects would allow water to spread across a wider area, thus relieving constricted channels of flow that cause erosion or siltation. The gravel added by these projects would move more often, particularly under LSJR Alternatives 3 and 4 (Chapter 6, Tables 6-10, 6-11, and 6-12). However, the amount of gravel (in the upper reaches) and sand (in the mid- to lower reaches) movement and bank erosion would not be any greater than analyzed in Chapter 6, Section 6.4.3, *Impacts and Mitigation Measures*, and, therefore, would not result in significant impacts on flooding, erosion, or sedimentation. Additionally, these restoration activities are not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential. Therefore, the incremental contribution of LSJR Alternatives 2, 3, and 4 would not be cumulatively considerable, and impacts would be less than significant.

Other projects, described in Table 17-1, that may involve both habitat restoration and changes in flows that could result in substantial erosion or siltation on- or offsite or flooding include the following.

- DSC Delta Plan
- Federal Energy Regulatory Commission (FERC) Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of the Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)
- Upper San Joaquin River Restoration Project (SJRRP), including Water Year 2010 Interim Flows Project
- Water transfers

As mentioned previously, the Delta Plan would not directly result in regulatory approvals, actions, or other projects, but could result in other agencies or entities taking future actions. The Delta Plan could affect the flooding, sedimentation, and erosion resources by recommending projects that involve habitat restoration or flow augmentation that are similar, in nature and effect, to the habitat restoration and flow augmentation projects described above. However, these restoration activities and flow augmentation projects are not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential.

The FERC projects would include the flows associated with the LSJR alternatives and any other flow adopted by FERC. Specifically, FERC projects undergoing relicensing must comply with conditions of water quality certification, such as the LSJR flow requirements, and any other minimum or bypass flows imposed through the relicensing process. However, these flows on the Tuolumne and Merced Rivers are not expected to increase peak flows in a way that would cause sufficient gravel transport to erode and undermine river levees. As such, the effects would not be substantially different from those analyzed in Chapter 6. While the FERC projects could include habitat restoration elements, the projects would focus on the upper gravel-bedded portions of these tributaries and, therefore, are not expected to result in levee instability or exceedance of existing channel capacities. Ongoing physical salmon habitat restoration activities located in the upper, gravel-dominated reaches on the tributary generally take place where past in-channel and channel-adjacent gravel mining has simplified the channel configuration and aquatic habitat, and reduced gravel transport. As such, these restoration activities are not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential.

Through the augmentation of flows in reaches of the SJR that have not recently had such levels of flow, the Upper SJRRP could increase the seepage and flooding potential. However, these effects would occur in the SJR upstream of the Merced River confluence and, thus, the LSJR alternatives would not contribute to these impacts. Additionally, the restoration flows expected on the SJR downstream of the Merced River confluence would be well below the channel capacities along the LSJR and in the southern Delta (Figure 6-3 in Chapter 6), and, thus, are not expected to result in a change to levee stability, flooding potential, or sediment and erosion potential.

Water transfers could increase flows; however, the increases would be well within normal channel capacities of the three eastside tributaries and the LSJR. As such, the transfers are not expected to result in a change to the levee stability, flooding potential, or the sediment and erosion potential. Consequently, even if expected levee improvements do not occur, these flows would not significantly impact flood flows, channel stability, or levees (DWR 2012).

Flows in the three eastside tributaries and LSJR are controlled by reservoir operations except during the highest flood flows in large storm events and occasionally when levees are breached (Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*; McBain and Trush 2002; DWR 2010, 2011, 2012). Furthermore, dams, irrigation water use, river bank protection, and levees maintain the rivers within their banks and reduce sediment transport and channel migration. Consequently, past, present, and reasonably foreseeable probable future projects would not result in cumulatively significant impacts on flooding, sediment, and erosion resources.

Cumulatively considerable impacts would not occur as a result of the LSJR alternatives. Flows would generally remain within existing flood channels and would not result in substantial alterations of the existing drainage patterns, substantial erosion or siltation, or substantial increases in bank erosion or mobilization of sediment. Also, flows would not result in a substantial increase in the rate or amount of surface runoff in a manner that would result in flooding. Flows imposed through the FERC process, which would include the flows associated with the LSJR alternatives and any other flow adopted by FERC, are not expected to increase peak flows in a way that would cause sufficient gravel transport to erode and undermine river levees. Therefore, the effects would not be substantially different from those analyzed in Chapter 6, Section 6.4.3, *Impacts and Mitigation Measures*.

Similarly, the restoration flows on the SJR below Friant Dam combined with the LSJR alternatives on the three eastside tributaries would generally be well below the channel capacities along the LSJR and in the southern Delta (Figure 6-3 in Chapter 6). The SJR restoration flows would increase average river flows but not peak flows associated with flood control releases during storm events. Consequently, even if expected levee improvements do not take place, these flows would not significantly impact flood flows, channel stability, or levees (DWR 2012). Projects implementing flood control measures, channel widening, or flood bypass would all reduce the potential for large flows to affect flooding.

Therefore, LSJR Alternatives 2, 3, and 4 would not result in a cumulatively considerable incremental contribution to cumulative impacts or significant cumulative impacts related to flooding, sedimentation, and erosion, and cumulatively adverse impacts would be less than significant.

In the extended plan area, flooding, sedimentation, and erosion would not occur as a result of the LSJR alternatives. As described in Chapter 6, Section 6.4.4*, Impacts and Mitigation Measures: Extended Plan Area*, there could potentially be more storage capacity under these alternatives on the Stanislaus and Tuolumne Rivers, which would help reduce flooding. Furthermore, the river channels on the Stanislaus, Tuolumne, and Merced Rivers are primarily contained in bedrock and would have minimal potential for increased sediment transport, erosion, or flooding under the LSJR Alternatives 2, 3, and 4. Past, present, and reasonably foreseeable probable future projects identified on Table 17-1 that could affect flooding, sediment, and erosion include the FERC Relicensing of Lyons Reservoir and the FERC Relicensing of the Don Pedro Hydroelectric Project, which could potentially affect operations of the CCSF/Hetch Hetchy reservoir system, upstream of New Don Pedro Reservoir in the extended plan area. FERC projects undergoing relicensing must comply with conditions of water quality certification, such as the LSJR flow requirements, and any other minimum or bypass flows imposed through the relicensing process. However, similar to the FERC relicensing in the plan area, the flows on the Stanislaus and Tuolumne Rivers are not expected to increase peak flows in a way that would cause sufficient gravel transport to erode and undermine existing river banks. Under the new licenses, these reservoirs would be operated consistent with flood control standards and rules. Therefore, LSJR Alternative 2, 3, and 4 would not result in a cumulatively considerable incremental contribution to cumulative impacts or significant cumulative impacts related to flooding, sedimentation and erosion.

Aquatic Biological Resources

As stated in Chapter 7, *Aquatic Biological Resources*, LSJR Alternatives 2, 3, and 4 would have a less-than-significant impact on aquatic biological resources in the plan area and would have significant and unavoidable impacts in the extended plan area. Under the SDWQ alternatives, salinity would generally remain the same as baseline conditions. As such, SDWQ Alternatives 2 and 3 would have no impact on aquatic biological resources and, therefore, are not considered further in this section.

The impacts considered in Chapter 7 are as follows.

- Impact AQUA-1: Changes in spawning success and habitat availability for warmwater species resulting from changes in reservoir water levels
- Impact AQUA-2: Changes in availability of coldwater species reservoir habitat resulting from changes in reservoir storage
- Impact AQUA-3: Changes in quantity/quality of physical habitat for spawning and rearing resulting from changes in flow
- Impact AQUA-4: Changes in exposure of fish to suboptimal water temperatures resulting from changes in reservoir storage and releases
- Impact AQUA-5: Changes in exposure to pollutants resulting from changes in flow

- Impact AQUA-6: Changes in exposure to suspended sediment and turbidity resulting from changes in flow
- Impact AQUA-7: Changes in redd dewatering resulting from flow fluctuations
- Impact AQUA-8: Changes in spawning and rearing habitat quality resulting from changes in peak flows
- Impact AQUA-9: Changes in food availability resulting from changes in flow and floodplain inundation
- Impact AQUA-10: Changes in predation risk resulting from changes in flow and water temperature
- Impact AQUA-11: Changes in disease risk resulting from changes in water temperature
- Impact AQUA-12: Changes in southern Delta and estuarine habitat resulting from changes in SJR inflows and export effects

In general, the LSJR alternatives would increase flows and decrease reservoir levels in both the plan area and the extended plan area. This could affect reservoir operations on the Stanislaus, Tuolumne, and Merced Rivers, flows in each of these tributaries, and flows in the LSJR and Delta, which could result in impacts on aquatic habitat and aquatic biological communities, including native and nonnative fish species. Reservoir operations of the major rim dams and flows in the three eastside tributaries downstream of these dams would generally fall within the ranges observed under baseline, and there would be general improvement (increase) in stream flows under the LSJR alternatives, relative to baseline. Therefore, the LSJR alternatives would have a less-than-significant impact on aquatic biological resources in the plan area. However, the LSJR alternatives could have a significant and unavoidable impact in the extended plan area because reservoirs upstream of the major rim dams in the extended plan area are smaller than the downstream rim reservoirs, potentially magnifying individual changes. Furthermore, required bypass flows may reduce the opportunity for these reservoirs to refill once they are drawn down. Reservoir drawdown could reduce the area and volume of water available for in-reservoir aquatic habitat, thereby affecting aquatic species, including fish. In addition, lower storage in the upstream reservoirs could result in increased water temperatures.

The LSJR alternatives could also affect flows in the southern Delta. The southern Delta is part of the larger Bay-Delta system and provides habitat for resident and migratory fish species. Essential habitats for salmonids and other fish species rely upon suitable water quality and water quantity conditions. For salmonids, these conditions must support juvenile and adult physiological transitions between fresh water and saltwater (NMFS 2009). Changes to estuarine habitat that degrade any of these conditions could have a negative effect on aquatic biological resources. Therefore, stressors similar to those described above for the three eastside tributaries and LSJR could influence the abundance and presence of fish in the southern Delta and Bay-Delta. In addition, conditions in the southern Delta are influenced by river inflow, tidal action, SWP and CVP water export facilities, local pump diversions, and agricultural and municipal return flows (Moyle 2002). Therefore, the geographic scope of this cumulative analysis focuses on projects within the three eastside tributaries in the plan area and the extended plan area, the three rim reservoirs, and the southern Delta.

Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on aquatic biological resources through the following mechanisms.

- Reduction of flows or change in reservoir operations in a manner that could change aquatic habitat availability and water temperatures and expose indicator species to pollutants and suspended sediments.
- Have an effect on habitat quality in the southern Delta by changing flows and circulation patterns in the southern Delta.

Projects, described in Table 17-1, that may reduce flows or change reservoir operations in a manner that could change habitat availability, water temperatures, and exposure to pollutants and suspended sediments for indicator species in the plan area and extended plan area include the following.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of the Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)
- Groundwater recharge projects
- NMFS BO (salmon, steelhead, sturgeon)
- Upper SJRRP, including Water Year 2010 Interim Flows Project
- Water transfers

The FERC projects would include the flows associated with the LSJR alternatives and any other flow adopted by FERC. However, these flows on the Tuolumne and Merced Rivers are not expected to change flows and reservoir storage in a way that would have effects substantially different from those analyzed in Chapter 7. NMFS BO actions include implementation of a year-round minimum flow regime that improves conditions for steelhead in the Stanislaus River, which has the potential to change reservoir storage levels in New Melones Reservoir on the Stanislaus River. However, reservoir storage is not expected to vary in a way that would have effects substantially different from those analyzed in Chapter 7. While groundwater recharge projects and water transfers have the potential to reduce the quantity of water that remains in the three eastside tributaries and the LSJR, the unimpaired flow requirements under the LSJR alternatives would still have to be maintained. Thus, flows are not expected to vary in a way that would have effects substantially different from those analyzed in Chapter 7. Lastly, although augmented flows in reaches of the SJR under the Upper SJRRP could increase the movement of contaminants into the LSJR and affect temperatures, these changes would have a less-than-significant impact on fall-run Chinook salmon and other native fishes. The increased flows would dilute existing levels of pollutants from agricultural runoff currently found in the river (e.g., Upper SJR to the confluence of the Merced) and modeling results of the Upper SJRRP determined little difference between baseline and the interim and restoration flow conditions. In addition, mobilization of pollutants is not expected because certain areas along the river would receive delivery of interim and restoration flows instead of existing CVP supplies. Furthermore, the increased flows under the LSJR alternatives would reduce any increased temperature effect that may occur as a result of the Upper SJRRP.

Projects, described in Table 17-1, that may have an effect on aquatic biological resources by changing flows and circulation patterns in the southern Delta include the following.

- California WaterFix
- NMFS BO

- USFWS BO (delta smelt)
- Update to the 2006 Bay-Delta Water Plan, Phase II

The NMFS and USFWS BOs are meant to protect fish listed under ESA from being jeopardized by the adverse effects of SWP and CVP export water operations by, at times, requiring reservoir releases, pumping reductions, or both, as well as habitat restoration and other actions. While reservoir releases and pumping reductions would reduce direct impacts on fish, less Sacramento River water could be drawn into the southern Delta, which could increase salinity. California WaterFix proposes new SWP Delta facilities, including three new screened intakes in the northern Delta that could be operated at least partially in lieu of existing SWP and CVP southern Delta pumping. California WaterFix could reduce entrainment and impingement of estuarine species in the southern Delta from existing SWP and CVP operations but could also change south Delta water circulation and salinity by reducing the amount of Sacramento River water drawn into the southern Delta compared to baseline. Furthermore, the update to the 2006 Bay-Delta Water Plan, Phase II could require greater Delta inflows, greater Delta outflows, or both, which could change south Delta water circulation and salinity.

The operations of the SWP and CVP are conditioned to meet the criteria in the 2006 *Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan), and would continue to be conditioned to meet any updates to the Bay-Delta Plan, including through future State Water Board water right actions. As new points of diversion for the SWP, California WaterFix must seek permits from the State Water Board. Such permits would be conditioned to ensure that aquatic biological resources are protected consistent with Bay-Delta Plan requirements. The update to the 2006 Bay-Delta Water Plan, Phase II must reasonably protect fish and wildlife beneficial uses. Therefore, the range of salinity levels and circulation patterns in the southern Delta are not expected to be substantially different from those analyzed in Chapter 7. Moreover, indicator species are historically adapted to much greater fluctuations in salinity than those required under the Bay-Delta Plan to protect southern Delta agricultural beneficial uses. Considering the combined impacts of past, present, the above-discussed projects and the LSJR alternatives, there would not be a significant cumulative impact on aquatic biological resources in the plan area. The combined effects on flow, which are necessary for habitat, temperature, water quality and circulation, and on reservoir levels at the rim dams are not expected to vary in a way that would have effects substantially different from those analyzed in Chapter 7. Moreover, there will be an overall increase in stream flows under LSJR alternatives. Therefore, LSJR Alternative 2, 3, and 4 would not result in a cumulatively considerable incremental contribution to significant cumulative impacts related to aquatic biological resources in the plan area.

However, significant cumulative impacts in the extended plan area could occur as a result of the LSJR alternatives. Similar to the plan area, past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on aquatic biological resources if they reduce flows or change reservoir operations in a manner that could change aquatic habitat availability and water temperatures and expose indicator species to pollutants and suspended sediments. Projects, described in Table 17-1, that may result in these types of impacts include the following.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of Lyons Reservoir
- San Francisco Public Utilities Commission (SFPUC) Hetch Hetchy Repair and Rehabilitation Program and Lower Cherry Aqueduct Emergency Rehabilitation

- TUD Phoenix Lake Preservation and Restoration project

These projects have the ability to modify the flow regime in the extended plan area on the Stanislaus and Tuolumne Rivers. Changes in the storage requirements or operation of the reservoirs under FERC relicensing, reservoir modifications, or as a result of increased diversions could significantly affect aquatic biological species in the Stanislaus and Tuolumne Rivers. These past, present, and reasonably foreseeable future projects could store and then divert water in the summer and fall, when the LSJR alternatives may result in reduced flows, particularly in the fall, as a result of earlier bypasses in the year. If this were to occur, there would likely be increases in temperature and reductions in overall available aquatic habitat. As such, the incremental contribution to aquatic biological resource impacts from LSJR Alternative 2, with adaptive implementation, or LSJR Alternatives 3 or 4, with or without adaptive implementation, would be cumulatively considerable when viewed in connection with the potential changes to aquatic habitat, temperature, and flow on the Stanislaus and Tuolumne Rivers as a result of the projects identified above. Cumulative impacts on aquatic biological resources in the extended plan area would be significant. There is no other feasible mitigation measure beyond what is proposed in Section 7.4.3, *Impacts and Mitigation Measures*, to reduce this impact to less-than-significant levels and, therefore, the cumulative impact would remain significant and unavoidable.

Terrestrial Biological Resources

As stated in Chapter 8, *Terrestrial Biological Resources*, LSJR Alternatives 2, 3, and 4 would have a less-than-significant impact on terrestrial biological resources in the plan area, and would have significant and unavoidable impacts on terrestrial biological resources in the extended plan area. Under the SDWQ alternatives, salinity would generally remain the same as baseline conditions. As such, SDWQ Alternatives 2 and 3 would have no impact on terrestrial biological resources and therefore are not considered further in this section.

The impacts considered in Chapter 8 are as follows.

- Impact BIO-1: Have a substantial adverse effect on any riparian habitat or other sensitive natural terrestrial communities identified in local or regional plans, policies, or regulations or by the CDFW or USFWS
- Impact BIO-2: Have a substantial adverse effect on federally protected wetland as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrologic interruption, or other means
- Impact BIO-3: Facilitate a substantial increase in distribution and abundance of invasive plants or nonnative wildlife that would have a substantial adverse effect on native terrestrial species
- Impact BIO-4: Have a substantial adverse effect, either directly or through habitat modifications, on any terrestrial animal species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW or USFWS
- Impact BIO-5: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan or conflict with any local policies or ordinances protecting biological resources

Overall, the LSJR alternatives would increase flows and decrease reservoir levels in both the plan area and the extended plan area. This could affect reservoir operations on the Stanislaus, Tuolumne, and Merced Rivers, flows in each of these tributaries, and flows in the LSJR and Delta, which could result in potential impacts on terrestrial habitat and terrestrial biological communities, including native and invasive species. The geographic scope of this cumulative analysis focuses on projects within affected areas (i.e., the riparian habitat adjacent to river channels and reservoir shorelines and the areas subject to surface water level fluctuations around the three rim reservoirs) along the three eastside tributaries in the plan area and the extended plan area, the three rim reservoirs, and the southern Delta.

Past and present cumulative effects of projects that have contributed to a decline in the diversity and abundance of terrestrial species and their habitats are discussed in the environmental setting section of Chapter 8. In general, future actions that could cumulatively affect terrestrial biological resources are similar to past and present projects. Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on terrestrial biological resources through the following mechanisms.

- Change in reservoir levels on the three eastside tributaries.
- Increase in the variability of changes to river flow volumes and timing.
- Physical modification of areas within and adjacent to the river channels such that there could be a substantial adverse effect on habitat or species of interest.

Projects, described in Table 17-1, that could change reservoir water surface elevations or increase the variability of changes to river flow volumes and timing include the following.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of the Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)
- NMFS BO (for salmon)
- Water transfers

The FERC projects would include the flows associated with the LSJR alternatives and any other flow adopted by FERC. However, these flows on the Tuolumne and Merced Rivers are not expected to change flows and reservoir storage in a way that would have effects substantially different from those analyzed in Chapter 8. NMFS biological opinion actions include implementation of a year-round minimum flow regime in the Stanislaus River, which has the potential to change reservoir storage levels in New Melones Reservoir. Additionally, while water transfers have the potential to reduce the quantity of water that remains in rivers in the plan area, the unimpaired flow requirements under the LSJR alternatives would still have to be maintained. Thus, flows are not expected to vary in a way that would have effects substantially different from those analyzed in Chapter 8.

Habitat restoration projects, habitat conservation plans, and other projects that involve construction in or adjacent to channels may alter the course of a stream or river or the adjacent habitat. In general, these projects are intended to benefit terrestrial biological resources by replacing riparian habitat that has been lost. Following is a list of such projects, which are described in Table 17-1.

- California EcoRestore
- Central Valley Project Improvement Act projects
- Dos Rios Ranch

- Gravel Mining Reach Floodway Restoration
- Habitat Restoration Project for the Lower Tuolumne River Corridor
- Knights Ferry Floodplain and Side-Channel Restoration
- Lower Tuolumne River Big Bend Project
- Merced River Ranch Floodplain Restoration
- Proposed expansion of the SJR National Wildlife Refuge

Habitat restoration projects, habitat conservation plans, and other similar types of projects are meant to recover wildlife species and habitat (including some riparian, floodplain, and adjacent terrestrial habitats). These efforts would work in conjunction to support terrestrial species and replace habitat that has been lost that could benefit terrestrial species. Such projects may have some short-term impacts on sensitive terrestrial species and habitat, such as indirect effects associated with construction noise or temporary removal of habitat. However, any disturbance that may take place would be in accordance with best management practices and applicable laws and regulations, and would be temporary and localized. Furthermore, such projects likely would be implemented in drier periods when the LSJR alternatives are less likely to contribute to related impacts. Overall, the LSJR alternatives would generally result in higher flows in the SJR and the three eastside tributaries below the rim reservoirs during the February–June period and could change rim reservoir storage levels. However, these additional flows are not expected to have significant impacts on riparian habitat, wetlands, or other sensitive natural terrestrial communities (Impacts BIO-1 and BIO-2) along river channels because the plants located in these areas can survive inundation, are resistant to the effects of scouring and deposition, and are growth-limited by water availability. Furthermore, the fluctuations of water elevation in the three rim reservoirs would be minimal under the LSJR alternatives and are not expected to affect riparian habitat or wetlands surrounding the reservoirs. Because a substantial change in riparian habitat would not be expected, special-status animal species would not be adversely affected (Impact BIO-4). In addition, because the impacts on riparian habitat and the special-status animal species that are dependent on it would be less than significant, the LSJR alternatives would not conflict with any plans protecting these biological resources (Impact BIO-5). Lastly, while flow changes and fluctuations in reservoir elevations could cause alteration of vegetation patterns in specific locations, there is no basis to suggest that increased flows would substantially increase the distribution and abundance of invasive plant species (Impact BIO-3). The incremental contribution of the LSJR alternatives' impacts when viewed in connection with past, present and probable future projects, such as those discussed above, is not cumulatively considerable. As such, LSJR Alternatives 2, 3, and 4 would not result in significant cumulative impacts related to terrestrial biological resources.

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, the LSJR alternatives would result in an overall slight reduction in salinity in the southern Delta. This impact would not be significant for riparian habitats and terrestrial wildlife and plant species which regularly tolerate fluctuation in salinity and experience tidal influences and salinity inputs from other sources. For example, native plant species in the southern Delta have adapted to brackish water and salinity levels that have historically existed in the southern Delta. Therefore, the incremental contribution of the LSJR alternatives would not be cumulatively considerable, and cumulative impacts would be less than significant in the southern Delta.

The area of potential effects for the extended plan area is similar to that of the plan area—it includes areas affected by fluctuations in reservoir levels and areas adjacent to the stream channels. However, in the extended plan area on the Stanislaus and Tuolumne Rivers, impacts of the LSJR alternatives for terrestrial biological resources would be potentially more significant than below the rim dams because the upstream reservoirs are smaller and the effects of potential changes in reservoir storage could be magnified. In particular, under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4, with or without adaptive implementation, the upstream reservoirs could experience substantial changes in reservoir volumes and surface water elevations that would not be experienced in the downstream rim reservoirs. In addition, channel flows in the extended plan area could decrease during the fall relative to baseline conditions since reservoirs have more open storage to fill. These changes could potentially result in reduced habitat conditions for terrestrial species along channel banks and reservoirs. Thus, as discussed in Chapter 8, the impacts associated with lower reservoir levels under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4, with or without adaptive implementation are significant and unavoidable.

Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on terrestrial biological resources in the extended plan area if they reduce flows or change reservoir operations in a manner that could change habitat availability adjacent to existing reservoirs on the Stanislaus and Tuolumne Rivers or adjacent to these rivers. In general, if projects lower reservoir elevations or river flows such that vegetation is reduced and wildlife habitat is reduced, significant impacts could occur. A reduction of river flows or reservoirs could occur if diversions were increased or operations changed to release more or less water during different times of the year. Projects, described in Table 17-1, that may result in these types of impacts include the following.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of Lyons Reservoir
- San Francisco Public Utilities Commission (SFPUC) Hetch Hetchy Repair and Rehabilitation Program and Lower Cherry Aqueduct Emergency Rehabilitation
- TUD Phoenix Lake Preservation and Restoration project

If these projects result in potentially lower flows in the summer or fall, when there may be effects associated with LSJR Alternatives 2, with adaptive implementation, or LSJR Alternatives 3 or 4 with or without adaptive implementation, the incremental cumulative contribution would be cumulatively considerable when considered with past, present, and reasonably foreseeable projects, such as those discussed above. This would result in a significant cumulative impact upstream in the extended plan area. There is no other feasible mitigation measure beyond what is proposed in Chapter 8, Section 8.4.4, *Impacts and Mitigation Measures: Extended Plan Area,* to reduce this impact. Therefore, the cumulative impacts related to terrestrial biological resources in the extended plan area would remain cumulatively significant and unavoidable.

Groundwater Resources

As stated in Chapter 9, *Groundwater Resources*, LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4, with or without adaptive implementation, would have significant and unavoidable impacts on the groundwater resources in the plan area, while LSJR Alternative 2 without adaptive implementation would have a less-than-significant impact on groundwater resources in the plan area. LSJR Alternatives 2, 3, and 4 would have a less-than-significant impact on groundwater resources in the extended plan area. The SDWQ alternatives would not result in a change in groundwater pumping or groundwater recharge from surface water that currently takes place. As such, SDWQ Alternatives 2 and 3 would have no impact on groundwater resources and, therefore, are not discussed further in this section.

The impacts considered in Chapter 9 are as follows.

- Impact GW-1: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge
- Impact GW-2: Cause subsidence as a result of groundwater depletion

Overall, the LSJR alternatives would reduce the amount of surface water available to those entities that currently divert surface water. To replace reduced surface water supplies, these entities could increase their reliance on groundwater, thereby increasing groundwater pumping and reducing groundwater recharge, relative to the baseline water balance, in the four groundwater subbasins underlying the plan area (the Eastern San Joaquin, Modesto, Turlock, and Extended Merced[4] Subbasins). Increased groundwater pumping could also result in groundwater quality impacts due to the potential for the migration of contamination and subsidence due to groundwater depletion. Other projects that could result in cumulative effects on groundwater resources would have the potential to deplete groundwater supplies either through increased groundwater pumping or interference with groundwater recharge.

Projects could result in a cumulative effect on groundwater resources if they increase reliance on groundwater, thereby depleting groundwater supplies or potentially interfering with groundwater recharge (Impact GW-1), which could also result in a potential migration of groundwater contamination, or if the increased groundwater pumping causes groundwater levels to decline such that there is an increased risk of subsidence (Impact GW-2). Accordingly, the geographic scope of this cumulative analysis on groundwater impacts focuses on projects within the four groundwater subbasins that underlie the plan area, as well as the extended plan area.

Groundwater levels in the four subbasins are primarily affected by inflows (i.e., natural and artificial recharge) and outflows (e.g., pumping and other discharges). Groundwater pumping has the greater impact on groundwater levels, especially as the subbasins have a long history of pumping more groundwater than the basins naturally recharge (i.e., overdraft). Reducing surface water availability could increase reliance on groundwater, as suppliers and groundwater users increase pumping to replace the lost surface water, thereby reducing groundwater levels. Lowering groundwater levels also has an effect on the risk of subsidence, especially in the Merced Subbasin, where there is evidence of subsidence (Sneed and Brandt 2015; Farr et al. 2015).

Past and present cumulative projects and activities that have contributed to declining groundwater levels in the four subbasins are discussed in the environmental setting section of Chapter 9. Examples of such activities that affect groundwater resources in the four groundwater basins include groundwater pumping for municipal, domestic, and agricultural uses (which has increased in recent decades), and the associated effects on groundwater quality by altered movement of groundwater contaminants towards wells.

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[4] As defined in Chapter 9, *Groundwater Resources*, the Extended Merced Subbasin is the Merced Subbasin plus the small area of the Chowchilla Subbasins that is between the Merced Subbasin and the Chowchilla River.

In general, future actions that could cumulatively affect groundwater resources in the four groundwater subbasins underlying the plan area are similar to past and present projects and include new municipal, domestic, and agricultural development, including infrastructure. Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on groundwater resources through the following mechanisms.

- Increase reliance on groundwater resources to meet increased potable water supply demands, thereby reducing groundwater levels or reducing groundwater recharge (both of which could also increase the migration of contaminants) or increasing subsidence.
- Reduce surface water availability, thereby increasing reliance on groundwater and thus reducing groundwater levels or reducing groundwater recharge (both of which could also increase the migration of contaminants) or increasing subsidence.

Several of the projects described in Table 17-1 are expected to encourage population growth, which could increase total municipal and industrial water use demands in a region that has historically relied on groundwater supplies. The projected population growth associated with these projects could increase total water demand and could increase reliance on groundwater resources to meet increased potable water supply demands. These projects include the following.

- California High Speed Rail Project
- Merced County's Castle Airport Master Plan (AMP) for development of Castle Airport
- Modesto Regional Water Treatment Plant (MRWTP) Phase Two Expansion Project
- University of California (UC) Merced 2020 Project
- Proposed Merced County 2030 General Plan
- Proposed Stanislaus County General Plan Update

Due to varied responses to reduced surface water deliveries and differences in groundwater conditions in the subbasins, the impacts of these projects cannot be determined with certainty. However, because municipalities and suppliers within the subbasins have historically relied on groundwater for all or a portion of their water supply, it is reasonable to conclude that reliance on groundwater would increase as the total water demand increases. The increased reliance could result in increased groundwater pumping, which could lead to an overall decline in groundwater levels in the subbasins and the potential for contaminants to move towards wells. Additionally, because lowered groundwater levels is associated with an increased risk of subsidence, these and similar projects could also increase the risk of subsidence in the subbasins.

Similarly, projects that reduce surface water availability could also result in significant cumulative impacts by increasing dependence on groundwater, which, again, could lead to an overall decline in groundwater levels and the associated potential for contaminant movement and subsidence. Projects that reduce surface water availability could also interfere with groundwater recharge activities, as recharge typically only occurs when there is excess surface water. Projects, described in Table 17-1, that could reduce surface water availability include the following.

- Water transfers

Although water transfers would tend to increase flows, there could be a flow shifting component that reduces flows at other times outside the transfer period. Increased flows would not increase natural instream groundwater recharge as the transfers do not increase the surface area from which recharge occurs. However, water transfers, which could involve transfers of water between entities within the plan area, transfers from outside the plan area to users within the plan area, or transfers from entities within the plan area to users outside the plan area, could result in a lowering of groundwater levels if groundwater is pumped in substitution for transferred water. Transfers could also reduce the availability of surface water for recharge activities if water that is transferred would otherwise have been injected into the aquifer or applied to spreading grounds where it could have percolated into the aquifer. Alternatively, water transfers could affect in-lieu groundwater recharge activities. Under in-lieu recharge programs, water users increase their surface water deliveries in order to temporarily decrease the amount of groundwater they pump from the aquifer. Decreased pumping allows natural recharge to accumulate in the underground aquifer for use during dry years. If water that otherwise would have been used to facilitate in-lieu recharge were to be transferred, then groundwater would still be pumped, which could result in a lowering of groundwater levels. The incremental contribution to groundwater resource impacts from LSJR Alternative 2 with adaptive implementation or LSJR Alternatives 3 or 4 with or without adaptive implementation would be cumulatively considerable when viewed in connection past, present, and probable future projects like the California High Speed Rail Project, the Castle AMP, the Modesto MRWTP Phase Two Expansion Project, the UC Merced 2020 Project, buildout under the proposed general plan updates for Merced and Stanislaus Counties, and water transfer projects. Cumulative impacts on groundwater resources in the plan area would be significant. There is no other feasible mitigation measure beyond what is proposed in Section 9.4.3, *Impacts and Mitigation Measures*, to reduce this impact to less-than-significant levels and, therefore, the cumulative impact would remain significant and unavoidable.

As discussed in Chapter 9, the geology in the extended plan area produces relatively small, localized, and isolated groundwater aquifers. This geology means that there is only one designated groundwater basin within the extended plan area, in Yosemite National Park, which has a relatively small amount of consumptive use. Given the small amount of consumptive use in the extended plan area, the LSJR alternatives would not significantly increase reliance on groundwater within the extended plan area, meaning that groundwater pumping is not anticipated to increase such that groundwater levels or recharge activities would be affected. Moreover, given the extended plan area geology and that groundwater pumping is not expected to significantly affect groundwater levels, there would be no significant risk of subsidence in the extended plan area or water quality impacts. The past, present, and reasonably foreseeable future projects identified in Table 17-1 do not have the potential to affect groundwater resources in the extended plan area because they are not expected to use existing groundwater resources in the extended plan area. As such, the LSJR alternatives' incremental contribution to cumulative impacts related to groundwater resources in the extended plan area would not be cumulatively considerable when viewed in connection with the effects of other past, present, and probable future projects

Recreational Resources and Aesthetics

As stated in Chapter 10, *Recreational Resources and Aesthetics*, LSJR Alternatives 2 and LSJR Alternative 3 without adaptive implementation would have a less-than-significant impact on recreation resources and aesthetics in the plan area, while LSJR Alternatives 3 with adaptive implementation and LSJR Alternative 4 with or without adaptive implementation would have significant and unavoidable impacts on recreational resources and aesthetics in the plan area. Within the extended plan area, LSJR Alternative 2 without adaptive implementation would have less-than-significant impacts on recreation resources and aesthetics, while LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation would have significant and unavoidable impacts on recreational resources and aesthetics in the extended plan area. Under the SDWQ alternatives, water quality in the southern Delta is expected to remain within historical ranges; furthermore, any changes in salinity levels within historical ranges are expected to be imperceptible to recreationists. As such, SDWQ Alternatives 2 and 3 would have no impact on these resources and, therefore, are not considered further in this section.

The impacts considered in Chapter 10 are as follows.

- Impact REC-1: Substantially physically deteriorate existing recreational facilities on the rivers or at the reservoirs
- Impact REC-2: Substantially degrade the existing visual character or quality of the reservoirs

Overall, the LSJR alternatives would increase flows in the three eastside tributaries and decrease reservoir levels. Increases in flows may physically deteriorate the condition of existing recreation facilities at reservoirs or rivers. Because many recreation activities are limited to a range of flows (e.g., swimming, use of boat put-ins, access to picnic areas and campgrounds), a substantial increase in flows during the recreation season (May–September) could result in recreationists being unable to use the river for certain types of in-water and on-bank activities. The reductions in reservoir levels could increase the distance between established facilities and the water, which could reduce use of existing recreation facilities (e.g., as reservoir levels decline boat ramps become less accessible which could result in fewer boaters on the water). Reductions in reservoir levels could also increase the frequency with which the non-vegetated ring around the perimeter of the reservoir would be exposed, thereby affecting visual aesthetics. As discussed in Chapter 10, the LSJR alternatives would have greater impacts on recreational resources and aesthetics within the extended plan area than the plan area.

The geographic scope of this cumulative analysis focuses on projects within the plan area and the extended plan area because this is where recreational and visual effects could occur. The geographic scope also includes the SJR up to Friant Dam, as changes upstream could impact in-water recreation along the SJR within the plan area. The southern Delta is not included within the geographic scope, as the salinity water quality objectives would have no impact on visual and recreational resources.

Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on recreation resources and aesthetics through the following mechanisms.

- Drawdown of reservoir levels on the three eastside tributaries.
- Increase in the variability of changes to flow volumes and timing.

Projects, described in Table 17-1, that could draw down reservoir levels on the three eastside tributaries include the following FERC projects.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of the Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)
- FERC Relicensing of Lyons Reservoir
- TUD Phoenix Lake Preservation and Restoration project

The Don Pedro and Merced River and Merced Falls FERC Hydroelectric Projects would include the flows associated with LSJR alternatives and any other flow adopted by FERC. Specifically, FERC projects undergoing relicensing must comply with conditions of water quality certification, such as the LSJR flow requirements, and any other minimum or bypass flows imposed through the relicensing process. However, these flows on the Tuolumne and Merced River are not expected to increase peak flows in a way that would cause substantial physical deterioration of on-bank recreation facilities. The proposed relicensing of New Don Pedro Reservoir and Lake McClure would include the maintenance of recreational facilities and potential changes to the release of water from the reservoir for power generation. In addition, the proposed relicensing could include actions, such as: increased flow, changes in timing of flow within a month or flows at different times of the year, fish passage, and, temperature control devices. If New Don Pedro Reservoir and Lake McClure are managed to include these types of actions, it is expected that the reservoirs could experience drawdown conditions, which could impact recreation resources and aesthetics. However, these conditions would be similar to historic conditions, and recreational amenities could be managed to provide continued access to recreationists. Furthermore, viewers typically anticipate the change in water elevation that results in the bathtub-ring effect with little vegetation and sediment. As such, the effects would not be substantially different from those analyzed in Chapter 10 for the plan area. The Lyons Reservoir FERC relicensing and the Phoenix Lake Preservation and Restoration Project are also not expected to result in a change in peak flows. However, depending on the drawdown that may occur at these reservoirs under the restoration and new FERC license, recreational and aesthetic resources may be affected, particularly in the summertime during prime recreation periods. In addition, diversions under the relicensing could occur in the summer or fall, which could potentially reduce the volume of water in the reservoir or river, depending on the scheduled release of water and the need for it downstream. These types of impacts could also occur under the FERC relicensing of the Don Pedro Hydroelectric Project as it may affect the operations of the CCSF's Hetch Hetchy system if CCSF contributes water supply to meet instream flows imposed as a condition of water quality certification associated with the relicensing or otherwise imposed through the relicensing process.

Other projects, described in Table 17-1, that could increase the variability of changes to flow volumes and timing include the following.

- Water transfers

Water transfers have the potential to increase flows, but the increases would be well within normal channel capacities of the three eastside tributaries and the LSJR and so are not expected to result in an increase in inundation of on-bank recreation facilities or result in physical deterioration of the facilities. Additionally, the transfers are unlikely to result in reductions of reservoir levels to such an extent that recreation facilities would be affected or the visual aesthetics be degraded. Therefore, these flows would not significantly impact recreation resources and aesthetics. Lastly, the effects of water right actions that implement the LSJR alternatives are accounted for in the effects associated with the LSJR alternatives and, therefore, would not result in additional impacts.

Additionally, some recreation management and improvement projects that are unrelated to flow and water levels may nevertheless have related impacts on recreation. Following is a list of such projects, which are described in Table 17-1.

- Tuolumne Wild and Scenic River Comprehensive Management Plan
- Merced Wild & Scenic River Final Comprehensive Management Plan

- Central Valley Vision
- SJR Blueway Plan

While unrelated to flow and water levels, these and similar projects would be expected to modify and enhance on-bank and in-water recreational opportunities. Similar types of past and present projects have gradually increased pressure on recreational resources, extracted water from the LSJR and three eastside tributaries, and altered the natural environment, including through urbanization of the viewshed. However, the projects also increased the number of recreational opportunities for the general public along the three eastside tributaries, the LSJR, and at the reservoirs by developing trails, boat launches, campsites, and other recreational amenities. The above-listed projects are expected to increase the number of recreational facilities and opportunities along the rivers and reservoirs, and implement other actions to ensure flows on the rivers suitable for recreation purposes and to preserve scenic views. Because similar projects have generally developed and promoted recreation, they have not had significant impacts on recreational amenities. However, development around the reservoirs and urbanization of the watersheds have had significant impacts on the views and viewsheds experienced by recreationists.

LSJR Alternative 2 would continue to support flows that are optimal for all types of recreation on the three eastside tributaries for the majority of the recreational season (May–September) and on the LSJR and would not substantially physically deteriorate existing recreational facilities at the reservoirs. Additionally, LSJR Alternative 2 with or without adaptive implementation would not substantially decrease May–September reservoir elevations, resulting in visual impacts. The incremental cumulative contribution of LSJR Alternative 2 with or without adaptive implementation to impacts on recreational resources on the rivers and reservoirs would not be significant when considered in combination with the past, present, and reasonably foreseeable probable future projects such as those described above. Therefore, under LSJR Alternative 2 with or without adaptive implementation, cumulative impacts would not be significant.

Under LSJR Alternatives 3 and 4 without adaptive implementation, the seasonal average frequency of flows conducive to swimming and wading (i.e., flows less than 500 cubic feet per second [cfs]) would decrease more than 10 percent on the Merced and Tuolumne Rivers, primarily due to reductions in May and June. There would be little change in high flows on these rivers from July–September, during the warmest months in the San Joaquin Valley, when swimming and wading are most popular. Thus, in-water recreation conditions are not expected to be substantially reduced. Flows may increase over the baseline in the extended plan area due to bypass flows, affecting in-river recreation. However, as described above, reasonably foreseeable probable future projects in the plan area and extended plan area are expected to increase recreation opportunities. Therefore, under LSJR Alternatives 3 and 4 without adaptive implementation, the incremental contribution of these impacts would not be cumulatively considerable and would not result in a significant cumulative impact on in-river recreation.

River flows greater than 2,500 cfs would increase in frequency on the Tuolumne River in May and June, and could result in an increase in the frequency of inundation of on-bank recreation areas under LSJR Alternative 3 without adaptive implementation (specifically, method 1). This inundation is not anticipated to substantially physically deteriorate these recreation facilities because they are capable of withstanding periodic inundation. Under LSJR Alternative 3 with adaptive implementation and LSJR Alternative 4 with or without adaptive implementation, modeled frequencies of flows greater than 2,500 cfs would substantially increase in the three eastside tributaries. Similar recreation impacts from increased river flows may occur in the extended plan area during bypass periods. Although on-bank recreation facilities on all of these rivers are purposefully built adjacent to, and within close proximity of, rivers and are able to withstand periodic inundation by higher flows, the frequency of flows predicted under these alternatives would likely result in much more frequent inundation of adjacent on-bank recreational facilities along these rivers relative to baseline, which is expected to contribute to substantial physical deterioration over time. Thus, the incremental contribution of LSJR Alternative 3 with adaptive implementation or LSJR Alternative 4 with or without adaptive implementation to the substantial physical deterioration of recreation facilities in the plan area and extended plan area over time would be cumulatively considerable when viewed in connection with the effects of the projects discussed above. As discussed in Chapter 10, Section 10.4.3, *Impacts and Mitigation Measures*, reducing flows could reduce this impact; however, such a reduction would directly contradict the purpose of these alternatives. In addition, the State Water Board has limited authority to impose mitigation measures on specific construction, operation, and maintenance of local recreational facilities to mitigate for the physical deterioration of recreation facilities. There are no other feasible mitigation measures the State Water Board can impose to reduce this impact to less–than-significant levels. As such, cumulative impacts related to recreational resources in the plan area and extended plan area would remain significant and unavoidable.

LSJR Alternative 3 without adaptive implementation and LSJR Alternative 4 without adaptive implementation are expected to cause a substantial decrease in May–September reservoir elevations at New Don Pedro Reservoir at the 30 percent cumulative distribution level for which increases in minimum reservoir elevations during the same period would not compensate. However, it is expected that this decrease would not substantially physically deteriorate existing recreation facilities at the reservoir, and all boat ramps would remain operable. Effects associated with reduced reservoir elevations at New Don Pedro Reservoir would be offset by increases in elevations under dry year conditions. Additionally, given the Class III designation of the views at New Don Pedro Reservoir (discussed in Chapter 10) and the typical fluctuations and the land-water interface experience of recreationists, the decrease in reservoir elevation is not expected to substantially degrade the visual quality. The incremental contribution of reduced elevations at New Don Pedro Reservoir would not be considered significant when considered with past, present, and reasonably foreseeable projects, such as those discussed above. Therefore, under LSJR Alternatives 3 and 4, the cumulative impact related to recreation and aesthetics in the plan area would not be significant. Elevations at New Melones Reservoir and Lake McClure would increase at the 30 percent cumulative distribution elevations under LSJR Alternatives 3 and 4, which would improve views such that there would be no significant cumulative impact.

In contrast to the discussion above, reduced reservoir elevations under LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4 with or without adaptive implementation would potentially result in significant impacts on views and recreation and aesthetics, as discussed in in Chapter 10, Section 10.4.4, *Impacts and Mitigation Measures: Extended Plan Area,* in the extended plan area. The incremental cumulative contribution would be significant when considered with past, present, and reasonably foreseeable projects, such as those discussed above, and there would be a significant cumulative impact upstream of the rim dams. Reservoirs upstream of the rim dams are much smaller such that impacts would be more pronounced and cumulatively considerable than in downstream reservoirs, even considering increased recreational opportunities from other projects. There is no other feasible mitigation measure beyond what is proposed in Section 10.4.4 to reduce this impact and, therefore, the cumulative impact related to recreational resources in the extended plan area would remain significant and unavoidable.

Drawdown in upstream reservoir storage particularly under LSJR Alternatives 3 and 4, with or without adaptive implementation, but also under LSJR Alternative 2 with adaptive implementation, in the extended plan area could result in reduced flows in the fall on the Stanislaus and Tuolumne Rivers. If flows are reduced such that sensitive viewers (e.g., recreationists) cannot see water in the river, the river becomes less of a defining feature of the overall landscape. This could substantially degrade the visual character and quality of views of the Tuolumne River, many parts of which have been designated wild and scenic, and the Stanislaus River, which can be viewed from Scenic Highways 108 and 4. The incremental contribution would be cumulative considerable when viewed in connection with the effects of the projects discussed above, especially considering the sensitivity of the area. Therefore, the cumulative impact on aesthetics would be significant, even though higher spring flows and lower fall flows are reflective of what would occur in a natural system. Providing more flows in the fall would mitigate this impact; however, it is counter to the LSJR alternatives' purpose to provide additional flows during February–June to more closely mimic the natural hydrograph for the protection of fish and wildlife beneficial uses, and is therefore infeasible. There are no other feasible mitigation measures that the State Water Board may impose. As such, impacts related to the aesthetics in the extended plan area would remain cumulatively significant and unavoidable.

Agricultural Resources

As stated in Chapter 11, *Agricultural Resources*, LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation would have significant and unavoidable impacts on the agricultural resources in the plan area, while LSJR Alternative 2 without adaptive implementation would have a less-than-significant impact on the agricultural resources in the plan area. LSJR Alternatives 2, 3, and 4 would have a less-than-significant impact on the agricultural resources in the extended plan area. Under the SDWQ alternatives, water quality within the southern Delta would generally remain the same as baseline conditions such that even salt-sensitive crops would not be considered significantly affected. As such, SDWQ Alternatives 2 and 3 would have a less-than-significant impact on agricultural resources.

The impacts considered in Chapter 11 are as follows.

- Impact AG-1: Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Important Farmland) to nonagricultural use
- Impact AG-2: Involve other changes in the existing environment which, due to their location or nature, could result in a conversion of farmland to nonagricultural use
- Impact AG-3: Conflict with existing zoning for agricultural use or a Williamson Act contract
- Impact AG-4: Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect

In general, the LSJR alternatives would increase flows and decrease reservoir levels, which would reduce the amount of surface water available for irrigation districts in the plan area to supply to agricultural acreage. A reduction in surface water for irrigation could lead to the potential conversion of Important Farmland to nonagricultural uses. As discussed in Chapter 11, there are many factors affecting whether or not farmland is ultimately converted to nonagricultural uses, particularly whether or not it is urbanized, but it is reasonable to assume that a portion of the

Important Farmland losing irrigation could be converted to nonagricultural uses. The LSJR alternatives do not require land purchases, grading, or construction of buildings or infrastructure. Therefore, the LSJR alternatives do not require conditional use permits; make zoning changes; cancel or rescind Williamson Act contracts; update general plans; or make changes to agricultural land use plans, policies, or regulations that could affect agricultural resources.

Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on agricultural resources through the following mechanisms.

- Urbanization of agricultural land or otherwise remove it from agricultural use.
- Reduction or limitation of the availability of surface water or groundwater for irrigation in the plan area such that agricultural land is potentially removed from agricultural use.
- Changes in the water quality of existing irrigation water supplies in the plan area such that agricultural land is potentially removed from agricultural use.

The geographic scope of this cumulative analysis focuses on projects within the irrigated agricultural acreage in the LSJR and SDWQ areas of potential effects as defined in Chapter 11, Agricultural Resources. There are more than 1 million acres of agricultural lands in California's San Joaquin Valley, which includes 527,793 acres of Important Farmland (65 percent of the agricultural acreage) in the LSJR area of potential effects, and 111,532 acres of Important Farmland (76 percent of the agricultural acreage) in the southern Delta. Important Farmland that is either Prime Farmland or Farmland of Statewide Significance is designated as such because of certain positive qualities, such as good soil characteristics like drainage, and the availability, amount, and frequency of irrigation. To maintain this status these lands must be irrigated 8 out of every 10 years and there must be adequate depth to the water table to support commonly cultivated crops..

Urban expansion, including infrastructure, habitat restoration efforts, and regional planning efforts that prioritize the implementation of water supply projects and other construction, could result in the removal of land from agricultural use in the plan area, including Important Farmland. Projects, described in Table 17-1, that would urbanize agricultural land or could otherwise remove it from agricultural use in the plan area, include the following.

- Urban growth in San Joaquin, Stanislaus, and Merced Counties (i.e., Proposed San Joaquin County 2035 General Plan, Merced County 2030 General Plan, Proposed Stanislaus County General Plan Update)
- Infrastructure projects (i.e.,., California High Speed Rail Project)
- Habitat restoration projects (i.e., Dos Rios Ranch and California EcoRestore)
- Regional planning efforts (i.e., DSC Delta Plan)

The San Joaquin Valley is one of the fastest-growing areas in California. For example, San Joaquin County converted 15,924 acres of Important Farmland to urban uses between 2000 and 2010 and estimates that an additional 12,133 acres of county land currently in agricultural/open space uses would be designated for nonagricultural/open space uses by 2035, mostly around existing urban centers, including 5,968 acres of Important Farmland. In Stanislaus County, between 2010 and 2012, urban and built-up land increased 293 acres and agricultural land decreased by 893 acres overall. However, Stanislaus County restricts growth under Measure E, passed in November 2007, which requires that land designated as agricultural or open space in the Land Use Element of the proposed *Stanislaus County General Plan* cannot be amended to residential or rezoned to residential without the approval of a majority of county voters. Measure E will remain in effect until December 31, 2036, unless it is otherwise amended by a future voter initiative. Merced County predicts that future growth resulting from implementation of its *Merced County 2030 General Plan* would result in both direct and indirect conversion of Important Farmland to urban or nonagricultural uses such as energy facilities, surface mining, the construction of infrastructure, and scattered rural residences. For example, total buildout of urban land uses designated in the *Merced County 2030 General Plan* could result in the new development of 14,683 acres by 2030.

Infrastructure and transportation projects, including roads and rail, could contribute to the conversion of Important Farmland. Transportation projects could be built upon Important Farmland and may also spur growth by creating new transportation hubs. For example, the California High Speed Rail Project calls for a high-speed rail system to be built and operated by 2029 with links between San Francisco and Los Angeles, as well as Sacramento and San Diego. The system would cover 800 miles with up to 24 stations, including several in the planned segment that traverses the LSJR area of potential effects. The project estimates that, for all statewide segments, a total of between 2,445 and 3,860 acres of farmland could be needed for railroad rights-of-way. New corridor alignments could also have the potential impact of severing existing parcels of farmland, potentially causing some to be converted to nonagricultural uses. Although the project connects existing urban areas, like many infrastructure projects, it may encourage some urbanization in currently undeveloped areas near project facilities.

Although habitat restoration projects maintain the open-space character of land, river and floodplain restoration efforts may require agricultural land along river corridors to be converted to nonagricultural uses, including to provide room for construction activities or for additional riparian habitat to complete the restoration projects. These changes could be permanent or temporary, and some of the land removed may be classified as Important Farmland. Examples of habitat restoration include Dos Rios Ranch and California EcoRestore. Dos Rios Ranch would restore land to provide wildlife habitat and flood control in the Central Valley on 1,600 acres of biologically rich floodplain, including 3 miles of riverfront on the SJR and 3 miles on the Tuolumne River. The plan area includes 119 acres of former agricultural land that was prone to flooding and planted in tomatoes, corn, alfalfa, and mixed row crops. California EcoRestore would help coordinate and advance at least 30,000 acres of critical habitat restoration in the Sacramento–San Joaquin Delta, mostly in the northern and central Delta, although some could occur in the southern Delta. Approximately 25,000 acres of the planned EcoRestore habitat is already required by the NMFS BO discussed in greater detail below. Another 5,000 acres are potential enhancements over and above the restoration required by the BOs. While some restored lands could remain in agricultural use, a significant portion is likely to be converted to nonagricultural use, including some lands that are Important Farmland.

Like general plans, regional plans do not direct construction of specific projects but may encourage certain types of activities and where they should be located. For example, the DSC was charged with developing and implementing a legally enforceable, long-term comprehensive management plan for the Delta. The Delta Plan must be designed to achieve the coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem while protecting and enhancing the unique cultural, recreational, natural resource and agricultural values of the Delta as an evolving place. As mentioned previously, the Delta Plan would not directly result in regulatory approvals, actions, or other projects, but could result in other agencies or entities taking future actions; however, the Delta Plan does encourage water supply reliability, habitat restoration, and other types of projects that could convert agricultural land to nonagricultural use.

On June 23, 2016, a Sacramento Superior Court judge issued a ruling setting aside the Delta Plan because parts of it were not consistent with the Delta Reform Act and ordering the DSC to revise the Delta Plan. However, any revised Delta Plan will continue to encourage water supply reliability and habitat restoration to fulfill the statutory mandates of the Delta Reform Act.

Development in the plan area, including residential, commercial, and industrial growth, is subject to local land use policies for agricultural mitigation that are designed to compensate for the premature and unnecessary conversion of agricultural land to urban uses, discourage noncontiguous urban development patterns, and promote the conservation, preservation, and continued existence of open space lands. These policies can include agricultural mitigation fees and agricultural conservation easement requirements based on acres of land converted. However, conversions of agricultural lands due to urban and rural development, including infrastructure, are still considered significant and unavoidable after mitigation (Merced County 2013; San Joaquin County 2014). The Delta Plan adopts policies that encourage certain types of projects including, but not limited to: potential surface water and groundwater storage facilities; water intakes; conveyance facilities (canals, pipelines, tunnels, siphons, and pumping plants); groundwater wells; water transfers; hydroelectric generation; ecosystem restoration; and development that could potentially affect agricultural resources. The DSC environmental review for the Delta Plan states that temporary project impacts on agricultural resources are likely to be fully mitigated. For projects that will result in the permanent conversion of agricultural land, depending on the nature of the conversion and the characteristics of the farmland to be converted, mitigation such as agricultural conservation easements, or contributing funds to a land trust or other entity qualified to preserve farmland in perpetuity, may be feasible. Nevertheless, the Delta Plan environmental review concludes that there will be permanent impacts on agricultural resources that are significant (Delta Stewardship Council 2013).

The High Speed Rail Project includes mitigation strategies to avoid or reduce impacts on agricultural land by sharing existing rail rights-of-way to the maximum extent possible, avoiding alignment options in established farmlands, and considering farmland preservation strategies. However, the High Speed Rail Project concludes impacts on farmland are still considered potentially significant and unavoidable, even after mitigation (California High-Speed Rail Authority and USDOT Federal Railroad Administration 2012).

Habitat projects retain land in open space use and do not destroy the chemical and biological integrity of soils; therefore, the differences between agricultural uses and habitat uses are largely economic and not environmental. Nevertheless, while many habitat projects, like EcoRestore, strive to adopt strategies (e.g., restoring degraded habitat as a priority before converting agricultural land or focusing habitat restoration efforts on developing new habitat on public lands before converting agricultural lands) in order to minimize impacts on agriculture, it is likely that agricultural land will still be converted (USBR et al. 2013).

The LSJR alternatives would allocate more water for instream flow requirements, as compared to baseline, which would reduce the amount of surface water available for irrigation districts in the plan area to supply to agricultural acreage, which could lead to the potential conversion of Important Farmland to nonagricultural uses. As discussed in Chapter 11, Section 11.4.3, *Impacts and Mitigation Measures*, while a reduction in water supply availability for agricultural purposes could potentially lead to a reduction in crop acreage and a potential conversion of Important Farmland to nonagricultural use, it is not a linear relationship. Non-irrigated lands could continue to be used for agricultural use through dry land farming, fallowing, grazing, dairy, and animal husbandry practices, and agricultural producers could mitigate reduced water availability for consumptive use by increasing irrigation efficiency, which would allow the amount of water currently applied to serve more acres. However, the State Water Board has limited authority to impose agricultural mitigation measures, and irrigation efficiencies and cropping decision would be the decisions of local farmers and local irrigation districts. While reducing flows could reduce the impacts of the LSJR alternatives, such a reduction would directly contradict the purpose of the LSJR alternatives. Thus, the incremental contribution of LSJR Alternative 2 with adaptive implementation or LSJR Alternatives 3 or 4, with or without adaptive implementation would be cumulatively considerable when viewed in connection with the effects of past, present, and future projects discussed above that could urbanize agricultural land or could otherwise remove it from agricultural use. There are no other feasible mitigation measures beyond what is proposed in Section 11.4.3, *Impacts and Mitigation Measures*, to reduce this cumulative impact to less-than-significant levels. As such, cumulative impacts related to agricultural resources in the plan area are significant and unavoidable.

The impacts of SDWQ Alternatives 2 or 3 on agricultural resources in the southern Delta are considered to be less than significant because water quality would not be degraded such that agricultural uses would be affected. Furthermore, these alternatives are meant to protect agricultural beneficial uses in the southern Delta. Therefore, the incremental contribution of SDWQ Alternatives 2 or 3 would not be cumulatively considerable, and cumulative impacts would not be significant.

Projects, described in Table 17-1, that could change water availability in the LSJR area of potential effects and potentially reduce irrigation to Important Farmland, thus increasing the likelihood that it could be converted to nonagricultural uses, include the following.

- Groundwater recharge projects
- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of the Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)
- Habitat restoration projects
- MRWTP Phase Two Expansion Project
- SGMA
- Water transfers

Groundwater recharge projects could take water that would otherwise remain in the Stanislaus, Tuolumne, and Merced Rivers and divert it to spreading basins that allow it to percolate into the ground or could capture it for direct injection into the groundwater aquifer. Water transfers from the three eastside tributaries could involve changes in the timing and flow of water as water is transferred between entities within the plan area, from outside the plan area to users within the plan area, or from entities within the plan area to users outside the plan area. FERC hydropower relicensing could require project-specific operational and infrastructure changes that could affect the timing and availability of water for irrigation. Habitat restoration projects could also divert surface water from the three eastside tributaries to restore and support natural habitat. The MRWTP would double the capacity of Modesto Irrigation District's (MID) water treatment plant allowing the City of Modesto to receive more water from MID for domestic use. SGMA requires sustainable management of the groundwater basins in the plan area by locally-created groundwater sustainability agencies (GSAs) that must adopt and implement groundwater sustainability plans

(GSPs) by 2020, if the basin is currently in chronic overdraft, or by 2022 for all other basins. GSPs utilize a 50-year planning horizon but must meet 5-year milestones and achieve sustainability within 20 years.

If a groundwater recharge project diverted water supply that was to otherwise be used for irrigation, there could be reductions in the number of irrigated acres, including acres of Important Farmland, which could lead to conversions to nonagricultural uses. Water transfers from the three eastside tributaries could reduce the availability of irrigation water availability and lead to reductions in irrigated acres, including acres of Important Farmland, which could lead to conversions to nonagricultural uses. In addition, farmers themselves may choose to fallow or idle their agricultural land in order to transfer water. Land that is temporarily fallowed is still considered to be in agricultural use. However, if land were permanently fallowed, that could be a direct conversion to nonagricultural uses. The FERC relicensing of the Don Pedro Hydroelectric Project, the Merced River Hydroelectric Project, and the Merced Falls Hydroelectric Project were considered in the effects analysis for the LSJR alternatives, including a wide range of potential flow releases. As such, these projects are expected to have effects similar to those identified for the LSJR alternatives, and the cumulative effects on agricultural resources are not expected to be significantly different from the analysis in Chapter 11. However, because other agencies have mandatory conditioning authority, and there may be project-specific operational and infrastructure changes required under these FERC projects, there may be localized changes in water availability in the Tuolumne and Merced Rivers resulting principally from re-operation of the reservoirs. If the water supply is reduced, there could be reductions in the number of acres that can be irrigated, which could lead to conversions of agricultural land, including Important Farmland, to nonagricultural uses. Habitat restoration projects could divert surface water from the three eastside tributaries, which could reduce surface water availability for agricultural uses. With reduced water supply, there could be reductions in the number of acres that can be irrigated. With irrigation reductions, there could be conversions, including conversions of Important Farmland, to nonagricultural uses. The MRWTP could transfer water from MID to the City of Modesto, which could reduce water availability for agricultural uses, which could in turn reduce the number of acres that can be irrigated and, therefore, potentially result in conversion to nonagricultural uses. Finally, SGMA requires sustainable groundwater management which, in the near term, could result in limits on groundwater supply for irrigation water. Historically, groundwater has been used for both direct irrigation and for surface water replacement, especially under drought conditions when surface water supplies are low. A reduced groundwater supply could result in a reduced number of acres that can be irrigated and could result in the conversion of agricultural land, including Important Farmland, to nonagricultural uses.

LSJR Alternatives 2 with adaptive implementation or LSJR Alternatives 3 and 4 with or without adaptive implementation would allocate more water for instream flow requirements, which would reduce the amount of surface water available for irrigations districts in the plan area to supply to agricultural acreage, which could lead to the potential conversion of Important Farmland to nonagricultural use. These impacts are considered cumulatively significant when considered in combination with past, present, and future projects described above that could reduce the water supply available for agricultural use, which could in turn lead to the conversion of agricultural land, including Important Farmland, to nonagricultural uses. There are no other feasible mitigation measures beyond what is proposed in Section 11.4.3, *Impacts and Mitigation Measures*, to reduce this cumulative impact to less-than-significant levels. As such, cumulative impacts would remain significant and unavoidable.

No reduction of agricultural acreage is likely under SDWQ Alternatives 2 and 3 because water quality within the southern Delta is expected to remain within the historic range. Under the program of implementation, the USBR would still be responsible for complying with the existing Vernalis salinity requirements established in the 2006 Bay-Delta Plan. Accordingly, the SDWQ alternatives would not degrade salinity conditions such that agricultural resources would be significantly affected. Projects, described in Table 17-1, that could cause changes in the water quality of existing irrigation water supplies in the plan area such that agricultural land is potentially removed from agricultural use include the following.

- California WaterFix
- NMFS BO (Chinook salmon, steelhead, sturgeon, and southern resident killer whales)
- USFWS BO (delta smelt)
- Update to the 2006 Bay-Delta Water Plan, Phase II
- Water transfers

The BOs are meant to protect fish listed under ESA from being jeopardized by the adverse effects of SWP and CVP export water operations by, at times, requiring reservoir releases, pumping reductions and other actions. Increased salinity concentrations could reduce crop yield or cause some crops to be removed from production. California WaterFix proposes new SWP Delta facilities, including three new screened intakes in the northern Delta, that could be operated at least partially in lieu of existing SWP and CVP southern Delta pumping. While California WaterFix could reduce entrainment and impingement of estuarine species in the southern Delta from existing SWP and CVP operations, it could also change south Delta water circulation and salinity by reducing the amount of Sacramento River water drawn into the southern Delta, thereby increasing salinity in the southern Delta. Transfers of water from the three eastside tributaries and SJR upstream of Merced could change the magnitude and timing of flows in the SJR and southern Delta. For example, WWCPs, such as the pending WWCP for the City of Turlock, could result in decreased flows in the LSJR during already low flow periods. Additionally, the update to the 2006 Bay-Delta Water Plan, Phase II could require greater Delta inflows, greater Delta outflows, or both. This could change southern Delta water circulation and salinity levels for agricultural resources.

The operations of the SWP and CVP are conditioned to meet the criteria in the Bay-Delta Plan and would continue to be conditioned to meet any updates to the Bay-Delta Plan, including through future State Water Board water right actions. As new points of diversion for the SWP, California WaterFix must seek permits from the State Water Board. Such permits would be conditioned to ensure that water for agricultural beneficial uses are protected consistent with Bay-Delta Plan requirements. Water transfers could change flow patterns, which could affect salinity concentrations in the southern Delta. Transfers that must pass through the Delta would generally improve south Delta salinity by increasing river water levels and inflow into the Delta and export pumping of transferred water would be subject to State Water Board conditions, including Bay-Delta Plan objectives for agricultural beneficial uses. Finally, the update to the 2006 Bay-Delta Plan, Phase II, must reasonably protect agricultural beneficial uses. Therefore, the range of salinity levels and circulation patterns in the southern Delta are not expected to be substantially different from those analyzed in Chapter 11. Consequently, past, present, and reasonably foreseeable probable future projects would not change the water quality of existing irrigation water supplies in the plan area such that agricultural land is potentially removed from agricultural use.

Considering the above limitations to adverse changes to water quality that could affect agriculture, LSJR Alternatives 2, 3, and 4 with or without adaptive implementation and SDWQ Alternatives 2 and 3 would not result in a cumulatively considerable incremental contribution to significant cumulative impacts related to changes in the water quality of existing irrigation water supplies such that agricultural land is potentially removed from agricultural use.

As discussed in Chapter 11, there are limited agricultural resources in the extended plan area and no designated Prime, Unique, or Farmland of Statewide Importance. Any effects on agricultural resources that result from reduced water supply would be similar to that described for the plan area but much smaller in magnitude and extent given the limited agricultural resources in the extended plan area. As discussed in Chapter 5, *Surface Hydrology and Water Quality*, projects in the extended plan area upstream of the rim dams would have very small effects on flows downstream of the rim dams and would not change surface water or groundwater availability for the irrigation districts. The past, present, and reasonably foreseeable future projects identified on Table 17-1 do not have the potential to affect agricultural resources in the extended plan area because they are not expected to convert designated agricultural uses to non-agricultural uses in the extended plan area. As such, the LSJR alternatives' incremental contribution to cumulative impacts related to agricultural resources in the extended plan area would not be cumulatively considerable when viewed in connection with the effects of other past, present, and probable future projects and would not result in a significant cumulative impact.

Cultural Resources

As stated in Chapter 12, *Cultural Resources*, LSJR Alternatives 2, 3, and 4 would have a less-than-significant impact on the cultural resources in the plan area and extended plan area. Under the SDWQ alternatives, salinity would generally remain the same as baseline conditions such that the baseline water quality conditions would not change. As such, SDWQ Alternatives 2 and 3 would have no impacts on cultural resources in the southern Delta and, therefore, are not considered further in this section.

The impacts considered in Chapter 12 are as follows.

- Impact CUL-1: Cause a substantial adverse change in the significance of a historical or archaeological resource
- Impact CUL-2: Disturb any human remains, including those interred outside formal cemeteries
- Impact CUL-3: Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature

In general, the LSJR alternatives would change the rates of flow of the three eastside tributaries and the LSJR, the maximum and minimum surface elevations of the three reservoirs, and the timing these surface water elevation, which could affect cultural resources. Other projects in the plan area that are considered in this cumulative impact assessment have the potential to result in changes in river flows and changes in reservoir water surface elevations. As discussed in Chapter 12, changes in flow upstream of the rim dams would be small and would not change flows downstream of the rim dams or in the southern Delta. Therefore, projects in the extended plan area would not impact on cultural resources in the plan area.

Projects could result in a cumulative effect on cultural resources if they cause a substantial adverse change in the significance of a historical or archaeological resource (Impact CUL-1); disturb any human remains, including those interred outside formal cemeteries (Impact CUL-2); or directly or indirectly destroy a unique paleontological resource or site or unique geologic feature (Impact CUL-3) within the fluctuation zones of the reservoirs and along the rivers. Accordingly, the geographic scope of this cumulative analysis focuses on projects within the areas of fluctuation in surface water elevation around the channels of the three eastside tributaries and the LSJR and the reservoirs within the plan area and the extended plan area that have the potential for significant known and unknown cultural resources.

Past and present cumulative projects that have contributed to cultural resource impacts are discussed in more detail in the environmental setting section of Chapter 12. These projects include ground-disturbing construction activities that have resulted in the disturbance of archaeological resources and demolition of built environment resources. Development for agricultural, transportation, mining, or urban purposes has resulted in the conversion of raw land and the associated disturbance of archaeological resources, buried human remains and fossils, and, in some cases, demolition of existing built environment structures and residences.

In general, reasonably foreseeable probable future actions that could cumulatively affect cultural resources include FERC relicensing projects and restoration programs. These projects may increase exposure or inundation of the resource through re-operation of reservoirs and associated downstream flows in areas with the potential for significant known and unknown cultural resources to exist. The projects, described in Table 17-1, may have effects on cultural resources through the following mechanisms.

- Changes in the rates of flow of the three eastside tributaries and the LSJR.
- Alteration of the maximum and minimum surface elevations in the three reservoirs.
- Alteration of the timing that fluctuations in surface water elevations occur in the three reservoirs.

Projects, described in Table 17-1, that could result in changes through any of the three mechanisms stated above include the following.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of the Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)
- NMFS BO (for salmon)

These and similar projects could result in the re-operation of the reservoirs, which could lead to a change in the amount and timing of water surface elevation fluctuations in the reservoirs and a change in the rates of flows downstream of the reservoirs. While the FERC projects would include the flows associated with the LSJR alternatives and any other flow adopted by FERC, the projects could result in project-specific operational and infrastructure changes and re-operation of the reservoir that could result in localized changes to reservoir elevations. Similarly, the NMFW biological opinion identified actions included the implementation of a year-round minimum flow regime in the Stanislaus River, which has the potential to change reservoir storage levels in New Melones Reservoir on the Stanislaus River.

Significant known and unknown cultural resources along the river channel margins within the fluctuation zones of the reservoirs could be affected by increased exposure or inundation. However, given previous natural and anthropogenic disturbances, and that the expected changes from the

LSJR alternatives and these projects are within historical fluctuations, there is a low potential for undocumented cultural resources to exist along the rivers or within the fluctuation zone of the reservoir.

There is generally a high potential for currently known and unknown significant historic or archaeological resources (Impact CUL-1) to exist at the three reservoirs. Under the LSJR alternatives, the historic or archaeological resources in the fluctuation zones of the reservoirs could experience variation in their physical environment due to changes in water level or siltation. However, these variations have an extremely low potential to cause a substantial adverse change in the characteristics that convey the historical significance of the resource. In addition, any significant historical and archaeological resources are protected and managed under the Historic Properties Management Plans (HPMPs) as part of the FERC hydropower water quality certifications for the Don Pedro Hydroelectric Project (FERC Project No. 2299) on the Tuolumne River and the Merced River Hydroelectric Project (FERC Project No. 2179), including Lake McClure, and by the resource management plan (RMP) administered by USBR at New Melones Reservoir on the Stanislaus River. These management plans would include standard unanticipated discovery and treatment measures should any previously unknown significant or potentially significant cultural resources be discovered during continued operation of the reservoirs.

There is a low potential for significant unknown historic or archaeological resources (Impact CUL-1) to be located within and adjacent to the three eastside tributaries and LSJR due to past anthropogenic and natural modifications within and adjacent to the river channels. Under the LSJR alternatives, average and seasonal flows are expected to remain within the existing channels that have been previously disturbed by natural flows and anthropogenic activities.

The potential for human remains (Impact CUL-2) to exist within the fluctuation zone of the reservoirs is low. Under LSJR alternatives, there would be a low potential for a change in reservoir elevation to disturb documented or currently undocumented human remains. In addition, documented or currently undocumented sites with human remains would be protected under federal and state laws and under the HPMPs prepared as part of the FERC hydropower water quality certifications for the Don Pedro Hydroelectric Project (FERC Project No. 2299) on the Tuolumne River and the Merced River Hydroelectric Project (FERC Project No. 2179), including Lake McClure, and by the RMP administered by USBR at New Melones Reservoir. Similarly, the potential for the presence of undocumented human remains within and adjacent to the three eastside tributaries and LSJR is considered low due to prior disturbance of the riparian corridors by natural and historic-era anthropogenic processes.

The potential for undocumented paleontological resources (Impact CUL-3) to be contained within the rock units in proximity to the reservoirs is low. Additionally, documented remains would be protected and managed under the existing cave management plans. Along the channel margins of the three eastside tributaries, any buried paleontological resources would be found at soil and rock depths too deep to be affected by changes in the rates of flow.

The incremental contribution of LSJR Alternatives 2, 3 and 4 with or without adaptive implementation to cultural resource impacts would not be significant when considered in combination with the impacts from the FERC relicensing projects and the BOs discussed above. Given the previous natural and anthropogenic disturbances and the fact that expected changes from the LSJR alternatives and these projects are within historical fluctuations, significant cumulative changes in cultural resources are unlikely. Moreover, cultural resources are protected and managed under the HPMPs for the Don Pedro and Merced Hydroelectric Projects and under the RMP for the New Melones Reservoir. Therefore, the LSJR alternatives would not result in significant cumulative impacts related to cultural resources.

Similar to the discussion in the plan area, there is a low potential for cultural resources to be disturbed in the extended plan area because either there is a low potential for them to exist due to previous anthropogenic disturbances or natural and continual hydrologic disturbances (e.g., floods), or the changes that occurred under baseline have previously affected cultural resources at reservoirs and, thus, conditions under the LSJR alternatives would be unlikely to result in impacts. Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on cultural resources in the extended plan area if they disturb areas beyond that of existing reservoirs, result in elevation changes beyond the historical variation of drawdown levels at reservoirs, or result in changes beyond existing river channels. Projects, described in Table 17-1, that may result in these types of impacts include the following.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of Lyons Reservoir
- TUD Phoenix Lake Preservation and Restoration project

All of these projects would result in potential disturbances at existing reservoirs, and it is expected that all of the projects, with the exception of the Phoenix Lake Preservation and Restoration Project, would occur within the design capacity of the existing reservoir. This means the reservoirs would continue to operate within the bounds of the design capacity constraints and within historical elevation variation. The Phoenix Lake Preservation and Restoration Project would construct a sediment bay, increase capacity, and would involve dredging. These activities have the potential to uncover unknown cultural resources that may not have been exposed during normal operations of this particular reservoir. Depending if cultural resources are uncovered and what they might be, this could be a significant impact. However, if the impact were to occur, it would be localized to this particular reservoir and would not contribute to an overall significant cumulative impact to cultural resources in the extended plan area. The LSJR alternative's incremental contribution to cumulative impacts related to cultural resources in the extended plan area would not be cumulatively considerable when viewed in connection with the effects of other past, present, and probable future projects.

Service Providers

As stated in Chapter 13, *Service Providers*, under the LSJR alternatives, surface water diversions would be reduced in both the plan area and the extended plan area. Table 17-2 summarizes the service provider impact determinations for each alternative in the plan area and the extended plan area. LSJR Alternative 2 without adaptive implementation would have less-than-significant impacts for Impacts SP-1, SP-2a, SP-2b, and SP-3. LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, would have less-than-significant impacts for Impacts SP-2a and SP-3. LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, would have significant and unavoidable impacts for Impacts SP-1 and SP-2b. SDWQ Alternative 2 would have a significant and unavoidable impact for Impact SP-1 and a less than a significant impact for Impact SP-2a. SDWQ Alternative 3 would have a less-than-significant impact for both Impacts SP-1 and SP-2a. SDWQ

Alternatives 2 and 3 are not relevant to Impacts SP-2b and SP-3 and, thus, have no cumulative impact. Therefore, they are not discussed further in this section.

The impacts considered in Chapter 13 are as follows.

- Impact SP-1: Require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects
- Impact SP-2a: Violate any water quality standards such that drinking water quality from public water systems would be affected
- Impact SP-2b: Violate any water quality standards such that drinking water quality from domestic wells would be affected
- Impact SP-3: Result in substantial changes to SJR inflows to the Delta such that insufficient water supplies would be available to service providers relying on CVP/SWP exports

Table 17-2. Summary of Chapter 13, *Service Providers*, Impact Determinations for LSJR and SDWQ Alternatives

		LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4	SDWQ Alternative 2	SDWQ Alternative 3
SP-1	Without AI	L	S	S	S (N)	L (N)
	With AI	S	S	S	N	N
SP-2a	Without AI	L	L	L	L (N)	L (N)
	With AI	L	L	L	N	N
SP-2b	Without AI	L	S (L)	S (L)	N	N
	With AI	S (L)	S (L)	S (L)	N	N
SP-3	Without AI	L	L	L	N	N
	With AI	L	L	L	N	N

Notes:
The impact determinations for SP-2b under LSJR Alternatives 2, without adaptive implementation, and LSJR Alternatives 3 and 4 in the extended plan area are different from those in the plan area.
The parentheses () denote the determination for the extended plan area.
AI = adaptive implementation (as described in Chapter 3, *Alternatives Description*).
S = significant and unavoidable impact
L = less-than-significant impact
N = no impact or not applicable

The geographic scope of this cumulative analysis focuses on projects within the plan area, the Eastern San Joaquin, Modesto, Turlock, and Extended Merced[4] Subbasins, other areas outside the plan area where there are service providers that are affected by the project and the extended plan area because these are the areas where impacts could occur.

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, changes in flow upstream of the rim dams would be minimal and would not change flows downstream of the rim dams or in the southern Delta. Therefore, under LSJR Alternative 2 without adaptive implementation and LSJR Alternatives 3 and 4, for Impacts SP-1, SP-2a, and SP-3, there would be similar impacts on service providers in the plan area and extended plan area. However, under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4, impacts for Impact SP-2b in the extended plan area would be less than significant, which is different from the plan area (where the impact for Impact SP-2b is significant and unavoidable). As discussed in Chapter 13, there were 55 service providers identified in the extended plan area. These service providers are geographically removed from the southern Delta and, thus, will not be affected by the SDWQ alternatives. Therefore, SDWQ alternatives, as they relate to the extended plan area, are not discussed further in this section.

Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on service providers through the following mechanisms.

- Reduction of surface water availability in the three eastside tributaries substantially, such that service providers would need to construct new or expanded existing water supply or wastewater treatment facilities to compensate for the reduction, the construction of which could result in significant environmental effects.
- Increase in groundwater pumping to compensate for reduced surface water availability such that groundwater resources are substantially depleted and groundwater levels are lowered.
- Degradation of water quality such that water quality from public water systems and domestic (i.e., private) wells violate drinking water standards.
- Reduction of SJR inflows to the Delta such that water supplies would be insufficient to service providers relying on CVP/SWP exports.

Projects, described in Table 17-1, that could change through any of the four mechanisms stated above, include the following.

- California High Speed Rail Project
- California WaterFix
- CV-SALTS and Central Valley-Wide SNMP
- Merced County’s AMP for Development of Castle Airport
- Proposed San Joaquin 2035 General Plan
- Proposed Stanislaus County General Plan Update
- UC Merced 2020 Project
- Update to the 2006 Bay-Delta Water Plan, Phase II

Development projects, such as the California High Speed Rail Project, development of Castle Airport and, the UC Merced 2020 Project, would increase water demand in the region where the development takes place. Service providers are planning for and have identified future water sources for municipal and agricultural uses. However, these projects could place pressure on the existing capacity of the service providers such that suppliers respond by constructing new water supply facilities or wastewater treatment facilities, or expanding existing facilities, the construction of which could cause environmental impacts. Furthermore, increased water demand may result in more groundwater being pumped, leading to depletion of groundwater resources. The draft EIRs for the proposed general plan updates for San Joaquin and Stanislaus Counties state that there will be significant impacts associated with the construction of new water supply or treatment facilities or expansion of existing facilities to meet water demands associated with buildout under these plans.

California WaterFix, CV-SALTS and SNMP, and the update to the 2006 Bay-Delta Plan, Phase II could alter the hydrodynamics in the southern Delta which could affect salinity. Although there may be occasions in which salinity would be increased, overall degradation of water quality is not expected in the southern Delta. In general, these projects are designed to maintain or improve water quality in the three eastside tributaries, the LSJR, and the southern Delta. For example, California WaterFix could lead to reductions in export salinity, and with additional export capacity, project water could be released to the SJR during low flow periods, which could improve water quality.

In general, under the LSJR alternatives with or without adaptive implementation, salinity in the southern Delta is not expected to differ much from baseline salinity and, overall, would decrease on average. Therefore, surface water quality is not expected to degrade such that drinking water standards would be violated in the southern Delta. Thus, the incremental contribution of the LSJR alternatives to cumulative impacts on drinking water quality (Impact SP-2a) in the SJR at Vernalis would not be cumulatively considerable since overall salinity would decrease under the LSJR alternatives with or without adaptive implementation, and cumulative impacts would be less than significant.

Sufficient surface water supplies are expected under LSJR Alternative 2 such that additional water supply or wastewater treatment facilities would not be required. Thus, the incremental contribution of the alternative to cumulative impacts (Impact SP-1) associated with the construction of new or expanded facilities would be less than significant. However, as discussed in Chapter 13, if adaptive implementation method 1 is implemented frequently and on a long-term basis, surface water diversions would be substantially reduced on the Tuolumne and Merced Rivers. Similarly, reductions in surface water supply diversions would occur under LSJR Alternatives 3 and 4 with or without adaptive implementation on these rivers as well as on the Stanislaus River. These reductions would affect service providers that rely primarily on surface water from these rivers and those providers that rely on some surface water from these rivers (Table 13-2 of Chapter 13). Some service providers are also planning to obtain additional surface water, which could be restricted under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation. As such, these LSJR alternatives would likely result in the construction of new water supply or wastewater facilities or expansion of such facilities in the plan area, the construction of which could cause environmental effects. Similarly, service providers in the extended plan area may need to construct new water supply or wastewater treatment facilities or expand such existing facilities. The incremental contribution of LSJR Alternative 2 with adaptive implementation, or LSJR Alternatives 3 or 4 with or without adaptive implementation would be significant when considered in connection with the new or expanded water supply or wastewater treatment facilities (Impact SP-1) as a result of the projects listed above. Therefore, there would be a significant cumulative impact in both the plan area and extended plan area.

If new or expanded facilities are required as a result of reduced surface water supply, the facilities would be carried out as part of individual projects associated with the service providers and could result in potentially significant environmental impacts. As discussed in Chapter 13, Section 13.4.3, *Impacts and Mitigation Measures*, the State Water Board would not be responsible for or have discretionary authority to approve the construction of any new or modified facilities and, therefore, it is not feasible for the State Water Board to impose possible mitigation measures (listed in Chapter 16, Table 16-38). Moreover, the State Water Board lacks authority to impose mitigation measures related to impacts such as air and noise. There is no feasible mitigation the State Water Board can implement to reduce environmental impacts resulting from the need for new or modified facilities (Impact SP-1). Therefore, under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation, the impacts would remain cumulatively considerable and significant.

Furthermore, given the potential reductions in surface water supply on the Stanislaus, Tuolumne, and Merced Rivers, pumping would be expected to increase in the Extended Merced, Modesto, and Turlock Subbasins, which would experience decreases in groundwater levels under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation. The Eastern San Joaquin Subbasin would also be affected under LSJR Alternative 4. These impacts on groundwater levels could result in reductions in groundwater supply and degradation of the quality of groundwater that the service providers and domestic well owners rely on as a source of drinking water. While water quality from public water system would not be impacted significantly, water quality from domestic wells could be impacted significantly, as discussed in Chapter 13, Section 13.4.3. The new or expanded water facilities that could be constructed as a result of projects like the California High Speed Rail Project, Castle Airport, and the UC Merced 2020 Project, could include new or expanded groundwater wells that would increase the groundwater pumping capacity. As discussed previously, increased pumping could reduce groundwater levels and potentially degrade groundwater as a source of drinking water. However, the incremental contribution of LSJR Alternative 2 with adaptive implementation or LSJR Alternatives 3 or 4 with or without adaptive implementation on drinking water quality from public water systems would not be significant when viewed in connection with these and other past and present projects; this is because public water system operators are required to comply with drinking water standards and would have to take corrective actions if their drinking water wells exceed the drinking water standards. As such, there would not be a cumulative significant impact (Impact SP-2a). In contrast, the incremental contribution of LSJR Alternative 2 with adaptive implementation or LSJR Alternatives 3 or 4 with or without adaptive implementation on drinking water quality from domestic wells would be significant when viewed in connection with the additional pumping and the potential groundwater degradation that may result from these projects. Additionally, there are no mechanisms to prevent domestic wells from using groundwater that exceeds drinking water standards as domestic wells are largely unregulated. Therefore, under LSJR Alternative 2 with adaptive implementation, or LSJR Alternatives 3 or 4 with or without adaptive implementation, cumulative impacts on drinking water (Impact SP-2b) in the plan area would remain cumulatively considerable and significant.

The State Water Board does not have authority to require implementation of mitigation that could reduce these cumulative impacts to a less-than-significant level, because it does not regulate domestic wells. As discussed in Chapter 13, the State Water Board can and does assist in identifying water quality threats through the Groundwater Ambient Monitoring and Assessment (GAMA) Program, the State Water Board's comprehensive groundwater quality monitoring program for California, and GeoTracker GAMA, a publically accessible online database of groundwater water quality data in California. Using the data collected in GAMA since year 2000, the State Water Board also provides the online, map-based tool "Is My Property Near a Nitrate-Impacted Water Well?" to assist domestic well owners in evaluating the risk of their wells to nitrate contamination.

Possible mitigation measures that owners and operators of domestic wells could undertake to avoid or reduce potential drinking water impacts at domestic wells include the following.

- Have a licensed contractor construct wells in accordance with well construction standards.
- Choose a location for a well to make sure it is free of potential sources of contamination.
- Test well water at certified drinking water laboratories to ensure its quality.

- If necessary, install a water treatment system tailored to the overall water chemistry and constituents that need to be removed (e.g., activated alumina filters, activated charcoal filters, air stripping, anion exchange, and ultraviolet radiation).
- If necessary, drill a new well that taps into a cleaner aquifer or find an alternative water source.
- Properly destroy unused and abandoned wells to prevent contamination.

In addition, local agencies can and should exercise their police powers and groundwater management authority under SGMA to address groundwater contamination so as to prevent and/or mitigate drinking water impacts on domestic wells. As discussed in the *Groundwater Resources* section of this chapter, SGMA requires local agencies to sustainably manage groundwater resources or, if local agencies are unable or unwilling, authorizes the state to intervene and develop an interim plan until locals can assume, or resume, management. Sustainable groundwater management is defined under SGMA as the management and use of groundwater in a manner that can be maintained during the 50-year planning and implementation horizon without causing undesirable results, including but not limited to: chronic lowering of groundwater levels; significant and unreasonable reductions in groundwater storage; significant and unreasonable degraded water quality; and significant and unreasonable subsidence that substantially interferes with surface land uses. (Wat. Code, § 10721.) Following the adoption of groundwater sustainability plans in either 2020 or 2022 (depending on if the basin is critically overdrafted), locals will have 20 years to achieve sustainable groundwater management. Plans must include milestones that, following initial submission of the plan, will be reviewed by the state every 5 years.

Thus, at this time, local agencies are vested with the mandatory duty to achieve sustainable groundwater management, which includes preventing significant and unreasonable degradation to water quality. These agencies can and should exercise their full authorities to address degradation of groundwater quality, both under SGMA and their police powers. Doing so would prevent and/or mitigate domestic well drinking water supply impacts. However, due to the inherent uncertainty in the degree to which this mitigation and those listed above may be implemented by local agencies and owners and operators of domestic wells, under LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, impacts related to drinking water impacts on domestic wells (SP-2b) would remain cumulatively considerable and significant in the plan area.

In the extended plan area, under LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation, bypass flows could be required more frequently and be larger than under baseline conditions, which could result in significantly less surface water available to the 12 service providers (listed in Chapter 13, Table 13-6), who collectively divert a total of 7.61 TAF annually. Increased groundwater pumping may occur; however, the increased pumping is not likely to affect groundwater quality and, thus, drinking water from public or private wells. This is because in the extended plan area, the amount of water that may be pumped is small given the small amount of total municipal use that occurs in the extended plan area, and pumping primarily occurs in fractured rocks which produces relatively small and isolated groundwater areas such that pumping would have minimal influence on contaminant migration. The projects listed above would not affect the groundwater quality in the extended plan area. Therefore, LSJR Alternatives 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation would not result in a cumulatively considerable incremental contribution to cumulative impacts or significant cumulative impacts related to drinking water (Impacts SP-2a and SP-2b), and cumulatively adverse impacts would be less than significant in the extended plan area.

With respect to Impact SP-3, in both the plan area and the extended plan area, there would be no reduction in annual average CVP/SWP exports. Hence, SJR inflows to the Delta would not be affected under LSJR Alternatives 2, 3 and 4. The incremental effect of the LSJR alternatives, when viewed in connection with the projects like the California High Speed Rail Project, Castle Airport, UC Merced 2020 Project, and water transfers, would not be cumulatively significant, and there would be no significant cumulative impact.

Under SDWQ Alternative 2, it is expected that some of the service providers (e.g., City of Tracy) would not be able to meet effluent limitations if the effluent limitations are set by the Central Valley Water Board to match the SDWQ Alternative 2 objective (i.e., 1.0 dS/m). Therefore, it can be expected that wastewater treatment requirements set by the Central Valley Water Board may be exceeded if a variance (i.e., under Central Valley Water Board Resolution No. R5-2014-0074, which authorizes variances that delays the deadline for compliance with salinity requirements) is not granted or its coverage expires. In order to comply, potential new facilities or modifications of existing facilities would be constructed as part of individual projects associated with the service providers could result in potentially significant environmental impacts. Projects like California WaterFix; CV-SALTS and SNMP; and the update to the 2006 Bay-Delta Plan, Phase II, could improve LSJR flow and water quality in the southern Delta, but it is unlikely that these projects could reduce the salinity of the effluent from the southern Delta wastewater treatment plant to such a degree that they would comply with a 1.0 dS/m effluent limitation. The incremental cumulative contribution of SDWQ Alternative 2 to the cumulative impact on service providers would be significant when viewed in connection with the new or expanded water supply or wastewater treatment facilities (Impact SP-1) that may be constructed as a result of projects, like the California High Speed Rail Project, Castle Airport, UC Merced 2020 Project, and the LSJR alternatives would result in a significant cumulative impact. As described above, there is no feasible mitigation the State Water Board could implement to reduce environmental impacts on service providers resulting from the need for new or modified facilities. Therefore, under SDWQ Alternative 2, this impact (Impact SP-1) would remain cumulatively considerable and significant.

Under SDWQ Alternative 3, potential new facilities or modifications to existing facilities are not expected, and all service providers would be expected to comply without new or modified facilities based on annual average EC data and previous EC violations. The incremental cumulative contribution of SDWQ Alternative 3 to cumulative impacts on service providers would not be considerable, and when viewed in connection with the related past, present, and reasonably foreseeable probable future projects listed above, this alternative would not result in a significant cumulative impact. Therefore, under SDWQ Alternative 3, this impact (Impact SP-1) would not be cumulatively significant. SDWQ Alternatives 2 and 3 are expected to maintain the historical range of salinity in the southern Delta because USBR would remain responsible for complying with the current salinity standards at Vernalis under its water right permits. Substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur under SDWQ Alternatives 2 or 3. Therefore, the incremental contribution of SDWQ Alternatives 2 or 3 to cumulative impacts on drinking water quality from public water systems would not be considerable. And, when viewed in connection with relevant projects listed above, cumulative impacts (Impact SP-2a) would not be significant.

Energy and Greenhouse Gases

As stated in Chapter 14, *Energy and Greenhouse Gases*, LSJR Alternative 2 with or without adaptive implementation would have a less-than-significant impact on energy and GHGs in the plan area, while LJSR Alternatives 3 and 4 with or without adaptive implementation would have significant and unavoidable impacts on energy and GHGs in the plan area. LSJR Alternative 2 with adaptive implementation, and LJSR Alternatives 3 and 4 with or without adaptive implementation would have significant and unavoidable impacts on energy and GHGs in the extended plan area, while LSJR Alternative 2 without adaptive implementation would have a less-than-significant impact on these energy and GHGs in the extended plan area. Under the SDWQ alternatives, salinity would generally remain the same as baseline conditions. As such, SDWQ Alternatives 2 and 3 would have no impact on energy and GHGs (Impacts EG-1 through EG-4) and, therefore, are not considered further in this section.

The impacts considered in Chapter 14 are as follows.

- Impact EG-1: Adversely affect the reliability of California's electric grid
- Impact EG-2: Result in inefficient, wasteful, and unnecessary energy consumption
- Impact EG-3: Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment
- Impact EG-4: Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions
- Impact EG-5: Effect of climate change on the LSJR and SDWQ alternatives

The LSJR alternatives would not require energy consumption or generate GHG emissions directly. However, the LSJR alternatives may affect hydropower generation by requiring more water to be released instream during the February–June period, making less stored water available for release in the summer. This, in turn, could result in additional energy generation at other facilities to compensate for the loss of hydropower generation. In addition, the LSJR alternatives could result in increased energy consumption associated with increased groundwater pumping. These activities could result in increased GHG emissions.

While the LSJR alternatives may result in a loss of carbon-free hydropower generation, it is anticipated that electricity derived from existing carbon-free hydropower sources would be compensated for by ramping up other generation facilities. Additionally, while other sources to compensate for electricity would include renewable energy sources, not all renewable energy is carbon free. For example, biomass- and biofuel-derived energy does emit GHGs.

No single project is likely to generate enough GHG emissions to cause an appreciable impact on climate change by itself; rather, climate change is the result of the GHG contributions of countless past, present, and future sources. The relevant inquiry is whether a project's incremental impact is cumulatively considerable in light of the global problem. California has policies and procedures in place to reduce statewide GHG production. For example, the California Renewables Portfolio Standard (RPS) (discussed in Chapter 14, Section 14.3.2, *State [Regulatory Background]*) requires that all electricity producers increase procurement from eligible renewable energy resources to 33 percent of total procurement by 2020. Energy production and consumption in the SJR Basin and California is anticipated to result in the use of more renewable energy sources over the next few decades. This is already evident, as the SJR Basin and surrounding areas have seen an increase in renewable energy projects, which will help the state meet the RPS requirements.

Past, present, and reasonably foreseeable projects, described in Table 17-1, may have effects on energy and greenhouse gas resources through the following mechanisms.

- Adverse effects on the reliability of California's electric grid by decreasing energy production or resulting in inefficient, wasteful, and unnecessary energy consumption.
- Generation of GHG emissions, either directly or indirectly, that may have a significant impact on the environment, or conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions.

The geographic scope of this cumulative analysis focuses on projects within the plan area and the extended plan area.

Projects, described in Table 17-1, that could adversely affect the reliability of California's electric grid or result in inefficient, wasteful, and unnecessary energy consumption include the following.

- FERC Relicensing of the Don Pedro Hydroelectric Project (FERC Project No. 2299)
- FERC Relicensing of Merced River Hydroelectric Project (FERC Project No. 2179) and Merced Falls Hydroelectric Project (FERC No. 2467)
- FERC Relicensing of Lyons Reservoir
- NMFS BO
- TUD Phoenix Lake Preservation and Restoration project
- Water transfers

These projects could result in re-operation of reservoirs that could lead to a change in the amount and timing of reservoir releases and water surface elevation fluctuations in the reservoirs. This has the potential to change the timing of and to reduce hydropower generation from the major dams on the Stanislaus, Tuolumne, and Merced Rivers. The overall operation of these reservoirs, however, is not expected to vary beyond the bounds analyzed for the LSJR alternatives. While hydropower generation may depend on the timing and amount of the transfer, surface water transfers typically must be within the same season, and so this would serve to limit potential changes. As discussed in Chapter 14, the transmission line loadings would not exceed the limits under contingency outage conditions under the LSJR alternatives because hydropower generation and reservoir elevation would not be substantially modified.

Additional energy generation at other facilities to compensate for a potential loss of hydropower under the LSJR alternatives would not be considered inefficient, wasteful, and unnecessary as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. Therefore, there would be no inefficient, wasteful, or unnecessary energy consumption under LSJR Alternatives 2, 3, and 4 with or without adaptive implementation.

The FERC projects listed above would include the flows associated with the LSJR alternatives and any other flow adopted by FERC. Additionally, the operation of New Melones Reservoir and Stanislaus River flows under the NMFS BO would include the flows associated with the LSJR alternatives. The effects of these other projects on grid stability and energy consumption would fall within the range of effects analyzed for the LSJR alternatives.

GHG emissions under LSJR Alternatives 2 would not exceed the 10,000 MT CO2e threshold with and without adaptive implementation. Therefore, GHG emissions would not have a significant impact on the environment under LSJR Alternative 2. GHG emissions under LSJR Alternatives 3 and 4 would exceed the 10,000 MT CO2e threshold with and without adaptive implementation. Thus, GHG emissions would have a significant impact on the environment under LSJR Alternatives 3 and 4 with or without adaptive implementation.

Projects, described in Table 17-1, that could generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment, or conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing GHG emissions, include the following.

- California High Speed Rail Project
- DSC Delta Plan
- Merced County's Castle AMP for Development of Castle Airport
- MRWTP Phase Two Expansion Project
- UC Merced 2020 Project

Physical improvements associated with these, and similar projects, could result in an increase in GHG emissions. GHG emissions are primarily generated during construction activities due to the considerable use of heavy equipment and construction vehicle trips, which are likely to have the greatest construction GHG emissions. Additionally, operation-phase impacts could occur directly (e.g., from maintenance activities) or indirectly (e.g., from increased electricity use).

RPS requirements would serve to reduce the carbon intensity of generated electricity, thereby helping to reduce the GHG emissions that would be associated with reduced hydropower generation and the increased use of electricity for groundwater pumping under LSJR Alternatives 3 and 4 with or without adaptive implementation. However, even if 33 percent of electricity in California were to be generated using renewable resources and the total GHG emissions resulting from LSJR Alternatives 3 and 4 were reduced by 33 percent, LSJR Alternatives 3 and 4 with or without adaptive implementation would still generate more than 10,000 MT CO2e per year (thereby exceeding the threshold) and would make a cumulatively considerable incremental contribution. Thus, impacts related to the energy and GHS resource under LSJR Alternatives 3 and 4 with or without adaptive implementation would be cumulatively considerable. There are no feasible mitigation measures beyond those proposed in Chapter 14, Section 14.4.3, *Impacts and Mitigation Measures,* to reduce this cumulative impact to less-than-significant levels.

As discussed in Chapter 14, Section 14.4.4, *Impacts and Mitigation Measures: Extended Plan Area*, the LSJR alternatives could affect energy (i.e., hydropower electrical production) resources in upstream reservoirs on the Stanislaus and Tuolumne Rivers. Hydropower production effects associated with the reservoir volume reduction under LSJR Alternatives 2 and 3 without adaptive implementation would be similar to baseline conditions. However, volume reductions would occur more frequently and be more severe during drought conditions, particularly under LSJR Alternatives 3 and 4 with or without adaptive implementation, but also under LSJR Alternative 2 with adaptive implementation. Consequently there could be significant hydropower production reductions at reservoirs under LSJR Alternatives 3 and 4 with or without adaptive implementation in the extended plan area, which could result in related adverse GHG emission if hydropower is replaced with non-renewable energy sources. Considering GHG emissions are cumulatively considerable since climate change is the result of the individual GHG contributions of countless sources, LSJR Alternatives 3 and 4 with or without adaptive implementation would result in cumulatively considerable GHG impacts in the extended plan area. There are no feasible mitigation measures beyond what is in Section 14.4.4 to reduce this cumulative impact to less-than-significant levels.

Finally, as discussed above, climate change results from multiple sources. Climate change, in combination with related projects, would not significantly affect the LSJR and SDWQ alternatives (Impact EG-5) because the proposed adaptive implementation would allow agencies to respond to changing circumstances with respect to flow and water quality that might arise due to climate change. Furthermore, the required periodic review and update of WQCPs continually accounts for changing conditions related to water quality such as climate change.

17.2.3 Additional Resource Areas Considered

Resource areas were initially evaluated using Appendix B, *State Water Board's Environmental Checklist*. Resource areas that were determined to need further analysis (i.e., impacts are listed as "Potentially Significant Impacts") are evaluated in the resource chapters (Chapters 5–14) and cumulative impacts are discussed in Section 17.2.2 of this chapter. However, some resource areas were determined to have "Less-than-Significant Impacts" and, thus, are only evaluated in Appendix B. These resource areas are discussed below to assess if their incremental impacts become cumulatively considerable when considered together with the potential impacts of the projects listed in Table 17-1. If an impact does not result in part from the LSJR and SDWQ alternatives, it is not discussed.

Air Quality

As discussed in Appendix B, Section III, the LSJR alternatives would result in changes in operations at the rim dams, which could result in decreased hydropower generation. This loss in hydropower generation may necessitate increased production from other power facilities to offset the loss. Implementation of the LSJR alternatives may also result in additional groundwater pumping to replace reduced surface water diversions. This groundwater pumping is anticipated to be within irrigation service areas and could require additional electrical use. It is assumed that electric pumps will be used to power increased groundwater pumping as electric pumps are cheaper and more efficient than diesel pumps on a long-term basis. Additionally, under the LSJR alternatives, reductions in surface diversion from the three eastside tributaries could result in removal of croplands from agricultural production (Threshold III[a]). As discussed in Threshold III(c), the net effect of this removal of croplands would not increase fugitive dust emissions. Furthermore, implementation of air quality plans would not be affected (Threshold III[b]). In general, potential impacts would increase as the percentage of unimpaired flows increases (i.e., LSJR Alternative 2 would have the fewest impacts and LSJR Alternative 4 would have the greatest impacts). However, as discussed in Appendix B, Section III, the LSJR alternatives would not result in a net change in pollutant emissions, and their implementation would be consistent with air quality management plans and regulations. The LSJR alternatives would not result in a cumulatively considerable incremental effect or contribute to a significant cumulative effect on air quality. The cumulative impact is less than significant.

Geology and Soils

Impacts on geology and soils are initially discussed in Appendix B, Section VI. An analysis of subsidence is included in Chapter 9, *Groundwater Resources*, and erosion is analyzed in Chapter 6, *Flooding, Sediment, and Erosion*. Erosion impacts related to reduced irrigation of irrigated lands are not cumulatively considerable and are less than significant. As discussed in Chapter 11, *Agricultural Resources*, while some agricultural land could be taken out of irrigated agricultural use as a result of the LSJR alternatives (particularly LSJR Alternatives 3 and 4), many of these lands could remain in agricultural use, even if they are not irrigated. Furthermore, the lands must remain in uses that are compatible with applicable local land use plans, policies or regulations. In addition, the implementation of agricultural practices to address dust control, weed abatement, and revegetation would result in an insubstantial amount of soil erosion or loss of topsoil. There would be no impacts on geology and soils specifically from implementation of the SDWQ alternatives. Any potential cumulative impacts related to subsidence and erosion caused by the LSJR alternatives are discussed in Section 17.2.2, *Cumulative Impact Analysis*, under the groundwater resources and flooding, sediment, and erosion sections, respectively. The other impact areas included in Appendix B, Section VI would not have impacts on geology and soils from implementation of the LSJR and SDWQ alternatives.

In general, potential impacts would increase as the percentage of unimpaired flows increases (i.e., LSJR Alternative 2 would have the fewest impacts and LSJR Alternative 4 would have the greatest impacts). However, other than those impacts discussed in Section 17.2.2 of this chapter, there are no cumulatively considerable impacts on geology and soils caused by the LSJR alternatives.

Recreation

Impacts on recreation resources are initially discussed in Appendix B, Section XV. Detailed analysis of recreation resources is included in Chapter 10, *Recreational Resources and Aesthetics*. As discussed in Appendix B, Section XV(b), any potential cumulative impacts related to recreation resources resulting from the LSJR alternatives are discussed in Section 17.2.2 under the *Recreation Resources and Aesthetics* section.7

However, other than those impacts discussed in Section 17.2.2 of this chapter, there are no cumulatively considerable impacts on recreation resources resulting from the LSJR alternatives.

17.2.4 Cumulative Impact Summary

In evaluating cumulative effects, the analysis in each of the resource chapters determines whether the incremental effects of the alternatives are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects (Cal. Code Regs., tit. 14, §§ 15130, 15064, 15065, 15130.) The existence of significant cumulative impacts caused by other projects alone is not necessarily substantial evidence that the alternative's incremental effects are cumulatively considerable. (Cal. Code Regs., tit. 14, § 15064.) Therefore, the cumulative impact analysis examines whether the overall cumulative impact (considering past, present, and reasonably foreseeable probable future projects) is significant and whether the alternatives make a cumulatively considerable incremental contribution to an overall cumulative impact. (Cal. Code Regs., tit. 14, §§ 15064, 15065, 15130.)

The cumulative analysis uses the impact threshold topics and significance criteria (as discussed in the cumulative impact analysis section of the relevant resource chapter) to evaluate the significance of any cumulative effects. Where appropriate, the cumulative analysis is combined for various project alternatives. The cumulative effects analysis applies to all LSJR and SDWQ alternatives. Table 17-3 summarizes the cumulative impact determinations for each resource for the plan area. Table 17-4 summarizes the differences in the cumulative impact determinations for each resource between the plan area and the extended plan area. Analysis of the cumulative effects of LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3, with respect to each resource can be found in Section 17.2.2, *Cumulative Impact Analysis*, of this chapter. Analysis of the cumulative effects of the No Project Alternative can be found in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*.

Table 17-3. Summary of Cumulative Impacts in the Plan Area

Resource	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4	SDWQ Alternative 2	SDWQ Alternative 3
Surface Hydrology and Water Quality	X	—	—	—	—	—
Flooding, Sediment, and Erosion	—	—	—	—	—	—
Aquatic Biological Resources	X	—	—	—	—	—
Terrestrial Biological Resources	X	—	—	—	—	—
Groundwater Resources	X	X	X	X	—	—
Recreational Resources and Aesthetics	X	—	X	X	—	—
Agricultural Resources	X	X	X	X	—	—
Cultural Resources	X	—	—	—	—	—
Service Providers	X	X	X	X	X	—
Energy and Climate Change	X	—	X	X	—	—

Notes:

Cumulative impact determinations in this table incorporate impacts both with and without adaptive implementation and reflect the most significant impact determination.

X = cumulatively significant impact.

— = no cumulatively significant impact.

Table 17-4. Summary of CEQA Significance Determinations for Cumulative Impacts in the Extended Plan Area

Resource	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Surface Hydrology and Water Quality	—	—	—
Flooding, Sediment, and Erosion	—	—	—
Aquatic Biological Resources	X	X	X
Terrestrial Biological Resources	X	X	X
Groundwater Resources	—	—	—
Recreational Resources and Aesthetics	X	X	X
Agricultural Resources	—	—	—
Cultural Resources	—	—	—
Service Providers	X	X	X
Energy and Climate Change	X	X	X

Notes:

Cumulative impact determinations in this table incorporate impacts both with and without adaptive implementation and reflect the most significant impact determination.

The No Project Alternative (LSJR/SDWQ Alternative 1) and SDWQ Alternatives 2 and 3 would have no effect in the extended plan area and, therefore, are not included in this table.

Gray shading denotes a change in the significance determination for the cumulative impacts for a resource between the plan area and extended plan area.

X = cumulatively significant impact.

— = no cumulatively significant impact.

17.3 Growth-Inducing Effects

CEQA requires a discussion of "the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment." (Cal. Code Regs., tit. 14, § 15126.2, subd. (d).) Growth-inducing projects include projects that have the potential to remove obstacles that inhibit population growth, or encourage and facilitate other activities that can significantly affect the environment, either individually or cumulatively. This section discusses the potential growth-inducing effects of the LSJR and SDWQ alternatives, and the No Project Alternative (LSJR/SDWQ Alternative 1).

The evaluation of potential growth-inducing impacts is qualitative and discusses the possible ways the LSJR and SDWQ alternatives could have growth-inducing effects. It also addresses whether the project alternatives would directly or indirectly foster economic, population, or housing growth; remove obstacles to growth; or encourage and facilitate activities that could significantly affect the environment, either individually or cumulatively. (Cal. Code Regs., tit. 14, § 15126.2, subd. (d).) Growth-inducing impacts are not to be construed as necessarily beneficial, detrimental, or of little significance to the environment.

The LSJR alternatives would establish new flow objectives on the LSJR and its three eastside tributaries for the purpose of protecting fish and wildlife beneficial uses. The SDWQ alternatives would amend the southern Delta salinity objectives, as identified in the 2006 Bay-Delta Plan, for the purpose of continuing to protect agricultural beneficial use of agriculture in the southern Delta.

SDWQ Alternatives 2 and 3 generally would maintain the historical range of salinity in the southern Delta. Accordingly, implementation of the salinity objective is unlikely to result in expanded agricultural uses or the development of additional agriculture lands, and thus, the alternatives would not foster economic growth or attendant population or housing growth, or remove obstacles to growth. As discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, point-source dischargers (e.g., wastewater treatment plants) may take certain actions to comply with the salinity requirements imposed through water quality permits, such as developing new source water supplies; implementing salinity pretreatment programs that require commercial, institutional, or industrial facilities or residential salinity source controls; or implementing an effluent desalination process at the wastewater treatment plants before treated effluent is discharged to the southern Delta. Such activities would result from the need to achieve compliance with the salinity objective; it would be speculative to assume that such activities would provide infrastructure or increased capacity that could serve other unrelated projects, such as additional housing or industrial developments. These compliance actions would not create new sources of water or wastewater treatment facilities that would foster population, economic, or housing growth, or remove obstacles to growth. Thus, SDWQ Alternatives 2 and 3 do not have growth-inducing effects.

LSJR Alternatives 2, 3, and 4 do not have growth-inducing effects for the following reasons.

- Under the LSJR alternatives, changes in river flows would generally result in more water remaining in the three eastside tributaries rather than being used for consumptive purposes. Therefore, changes in river flows would not increase the reliable water supply and would not directly or indirectly induce economic, population, or housing growth.
- Under the LSJR alternatives, changes in river flows in the three eastside tributaries would generally result in an increase in Delta inflow. This is because additional flows would be required to remain in the tributaries, which ultimately discharge into the southern Delta from the LSJR. Within the legal Delta, water availability and quality are not limiting growth factors; numerous unrelated constraints (e.g., flooding risk and protections of agricultural lands) limit growth potential under existing conditions. Therefore, changes in river flows would not remove existing growth-limiting factors (i.e., obstacles to growth), and would not directly or indirectly induce growth.
- Under the LSJR alternatives, changes in river flows in the three eastside tributaries would generally result in slightly increased Delta outflow. To the extent that outflow is needed to meet water quality objectives (e.g., the Delta outflow objective), it is not available for appropriation. Therefore, an increase in outflow would not increase the reliable water supply and would not directly or indirectly induce growth. The potential for increases in exports is discussed below.
- The LSJR alternatives may potentially result in a reduction of surface water availability, thereby reducing the amount of surface water available for agricultural and other purposes. While this could result in land being removed from agricultural production, the location and area of such lands cannot be predicted with certainty. Therefore, the possibility that such lands would then be converted to housing or other economic uses is speculative.
- Modeling predicts a potential for minor increases in exports under the LSJR alternatives, on an average annual basis. Average annual increases in Delta exports under LSJR Alternatives 2, 3, and 4 were estimated to be 18 TAF, 76 TAF, and 194 TAF, respectively. These increases are minor because they represent only a small percentage (0.4 percent, 1 percent, and 4 percent under LSJR Alternatives 2, 3, and 4, respectively) of total Delta exports, which historically

averaged 5,185 TAF per year between 1995 and 2013. Such minor increases in exports under the LSJR alternatives are not considered to be growth-inducing for the following reasons.

- Delta exports make up less than half of the water supplies available to and used in California south of the Delta and in the CVP and SWP export service areas.
- Although modeling predicts minor increases in exports on an average annual basis, the annual variability of exports is high and actual exports are controlled by a variety of factors, including: weather patterns; annual agricultural practices; economic conditions; and availability of water from other sources (e.g., groundwater, local water sources, recycled water, Colorado River supplies) south of the Delta and in the CVP and SWP export service areas. Additionally, the timing and amount of permissible exports are controlled by many other laws, regulations, permits, and water rights, only some of which are related to water availability in the Delta for export, and these requirements vary from year to year. The minor modeled increases in exports are well within the range of normal variation experienced from year to year.

The No Project Alternative (LSJR/SDWQ Alternative 1) assumes full compliance with all flow and water quality objectives in the 2006 Bay-Delta Plan as implemented through D-1641 and the NMFS BO on the Stanislaus River (which is included in the baseline). The changes in river flow and salinity level under No Project Alternative would be small as compared to baseline. For the reasons identified above regarding the potential effects of the LSJR and SDWQ alternatives on growth, implementation of the No Project Alternative would not directly or indirectly foster economic, population, or housing growth; remove obstacles to growth; or facilitate or encourage other such activities.

17.4 Significant Irreversible Environmental Changes

Section 15126.2(c) of the State CEQA Guidelines directs a discussion of the significant irreversible environmental changes that would be caused by a proposed project. Section 15127(a) of the State CEQA Guidelines requires information about irreversible changes to be included in connection with the adoption, amendment, or enactment of a plan of a public agency, such as the amendment of the 2006 Bay-Delta Plan by the State Water Board. An significant irreversible change to resources is the permanent loss or damage of resources for future or alternative purposes. Irreversible changes to resources result in resources that cannot be recovered or recycled, or those that are consumed or reduced to unrecoverable forms. They can be caused, either directly or indirectly, by the use of natural resource so that it cannot be restored or returned to their original condition.

The LSJR and SDWQ alternatives and their implementation would not directly result in the significant irreversible commitment of resources because their primary effect is to protect water quality for fish and wildlife and agricultural beneficial uses. However, certain alternatives may indirectly result in the permanent loss or damage of resources for future or alternative purposes or may use natural resources such that they cannot be restored or returned to their original condition. These are described below.

LSJR Alternative 2 with adaptive implementation and LSJR Alternatives 3 and 4 with or without adaptive implementation may have potentially significant impacts associated with groundwater, agricultural, and energy resources, which are resources may not be recovered or recycled or may be used such they cannot be restored or returned to their original condition. Increased groundwater pumping could potentially deplete groundwater supplies and cause interference with groundwater recharge; both of which could increase the possibility of overdraft. As discussed in Chapter 9, *Groundwater Resources*, various actions, such as implementation of SGMA, groundwater recharge projects, conjunctive use, and other management projects, would benefit groundwater resources. Groundwater use could potentially be mitigated, through implementing management controls to reduce or manage pumping in groundwater subbasins; however management varies by subbasin. Additionally, given the variability of local agency response to implementing sustainable practices and the condition of the groundwater resources in the subbasins (including overdrafted and critically overdrafted groundwater basins), the LSJR alternatives could result in potentially significant irreversible environmental changes to groundwater resources. Reductions in surface water supply may result in reduced surface water availability for agricultural uses. In turn, this may result in some agricultural lands being removed from agricultural use and converted to other uses. Depending on the new use (e.g., housing or industrial uses), the change could be considered irreversible. While the location and extent of such conversion is speculative, the LSJR alternatives could result in potentially significant irreversible environmental changes to agricultural resources. The LSJR alternatives may affect hydropower generation by requiring more water to be released instream during the February–June period, making less stored water available for release in the summer. This, in turn, could result in additional energy generation at other facilities to compensate for the loss of hydropower generation, as well as hydropower generation. As discussed in Chapter 14, *Energy and Greenhouse Gases*, the other facilities could generate energy from hydropower. However, if they do not, they would likely result in the generation of energy that may not be able to be replaced and as such could result in a potentially significant irreversible environmental changes to energy resources.

To the extent that the LSJR Alternatives 2, 3, or 4 with or without adaptive implementation would result in the construction or maintenance of indirect actions or non-flow measures, this would likely result in the use of resources that may not be recovered or recycled or may be used such they cannot be restored or returned to their original condition. Depending on the scale and size of the indirect actions or non-flow measures described in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, the following resources could be used such that they cannot be recovered or recycled: energy expended in the form of electricity, gasoline, diesel fuel, oil for construction equipment and transportation vehicles that would be needed; mined materials, such as sand, gravel, steel, lead, copper, or other metals as needed for the particular indirect action or non-flow measure, and other potentially petroleum based products, such as asphalt or plastic. The level of reduction or change to these types of resources would depend on the size and scale of the indirect action or non-flow measure. In addition, the indirect action of constructing new surface water supplies (i.e., surface water reservoir) would likely result in the use of forest land, or potentially other land uses, such that it could not be recovered or used for another purpose. This potential loss or change would depend on the size and location of a reservoir. Similar to the use of resources described above for construction and maintenance, it is expected that the operation of facilities under the following indirect actions could also result in energy expended in different forms (e.g., electricity): recycled water sources for water supply, in-delta diversions, and water supply desalination.

To the extent that SDWQ Alternatives 2 or 3 would result in the construction or maintenance of other facilities because of a method of compliance or the program of implementation, this would likely result in the use of resources that may not be recovered or recycled or may be used such that they cannot be restored or returned to their original condition. Depending on the scale and size of the facilities described in Chapter 16, the following resources could be used such that they cannot be recovered or recycled: energy expended in the form of electricity, gasoline, diesel fuel, oil for equipment and transportation vehicles that would be needed; mined materials, such as sand, gravel, steel, lead, copper, or other metals as needed for the particular facility; and other potentially petroleum based products such as asphalt or plastic. The level of reduction or change to these types of resources would depend on the size and scale of the facility being constructed and construction footprint. To the extent the SDWQ alternatives would result in the construction of facilities (e.g., desalination facilities), those facilities likely would be constructed on lands already committed to commercial, industrial, and institutional uses. However, if facilities are not constructed near or adjacent to existing facilities (e.g., canals associated with new source water supplies or agricultural return flow salinity control), then those types of facilities could result in a change to land such that it cannot be restored or returned to its original condition. Similar to the use of resources described above for construction and maintenance, it is expected that the operation of facilities under the following indirect actions could also result in energy expended in different forms (e.g., electricity): new source water supplies, salinity pretreatment programs, desalination, and low-lift pumping stations.

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) may have potentially significant impacts associated with agricultural resources associated with reduced surface water from the Stanislaus River. Similar to the effects described above for agricultural resources, this could result in agricultural lands being removed from agricultural use and converted to other uses. While the location and extent of such conversion is speculative, the LSJR alternatives could result in potentially significant irreversible environmental changes to agricultural resources. As described in Chapter 15, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)* if the southern Delta salinity objectives are not applied to existing municipal dischargers, then the No Project Alternative would not result in a change to the NPDES permit or other discharger requirements and the No Project Alternative would not result in the need to expand existing facilities or infrastructure. Thus significant irreversible changes would not occur and the use of resources would not occur such that they cannot be recovered or recycled. However, if the southern Delta salinity objectives are applied, then effects would be similar to those described above for SDWQ Alternatives 2 or 3. It would be expected that during construction, maintenance, and operation could result in significant irreversible changes to energy expended in the form of electricity, gasoline, diesel fuel, oil for equipment and transportation vehicles that would be needed; mined materials, such as sand, gravel, steel, lead, copper, or other metals as needed for the particular facility; and other potentially petroleum based products, such as asphalt or plastic. The level of reduction or change to these types of resources would depend on the size and scale of the facility being constructed and construction footprint under the No Project Alternative. Similarly, if facilities are not constructed near or adjacent to existing facilities (e.g., canals associated with new source water supplies or agricultural return flow salinity control) then they could result in a change to land such that it cannot be restored or returned to its original condition.

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Chapter 18
Summary of Impacts and Comparison of Alternatives

18.1 Introduction

This chapter compares the alternatives that are described in Chapter 3, *Alternatives Description*, and evaluated in Chapters 5–15, and summarizes their environmental impacts. It also incorporates the evaluation and determinations identified in Chapter 16, *Evaluation of Other Indirect and Additional Actions*. The California Environmental Quality Act (CEQA) requires an analysis of a range of reasonable alternatives to a project, or its location, that will feasibly attain most of the project's objectives but that would avoid or substantially lessen any of the significant effects of the project. (Cal. Code Regs., tit. 14, § 15126.6(a); id., tit. 23, § 3777(b)(3).) Accordingly, this recirculated substitute environmental document (SED) analyzes four Lower San Joaquin River (LSJR) alternatives and three Southern Delta Water Quality (SDWQ) alternatives that feasibly meet the objectives of the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan) amendments, including LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative). This analysis is intended to provide sufficient information about the environmental effects of each alternative to allow for informed decision-making. Section 15126.6 of the State CEQA Guidelines also requires an evaluation of the comparative merits of the alternatives and an identification of an environmentally superior alternative among the other alternatives if the environmentally superior alternative is the no project alternative.

As described in more detail in Chapter 3, *Alternatives Description*, the plan amendments[1] would include new February–June LSJR flow objectives for the protection of fish and wildlife beneficial uses and an associated program of implementation. The plan amendments would also modify the existing SDWQ objective for the protection of agricultural beneficial uses and the associated program of implementation for that objective. The LSJR flow objectives would be implemented through water right actions and water quality actions, including Federal Energy Regulatory Commission (FERC) hydropower licensing processes. The southern Delta salinity objective would be achieved through water right and water quality control actions. Both the LSJR flow objectives with adaptive implementation and the southern Delta salinity objective comprise the plan amendments, and the flow objectives may affect salinity as discussed in the various resource chapters (Chapters 5–14).

The LSJR alternatives, simply stated, are as follows.

- LSJR Alternative 1, which is the No Project Alternative, would be a continuation of, and full compliance with, the 2006 Bay-Delta Plan and the flow requirements as described by the plan and implemented through the State Water Board's Water Rights Decision 1641 (D-1641)[2].
- LSJR Alternative 2 would establish a range between 20 and 30 percent, with 20 percent as the starting percentage of unimpaired flow[3] in the program of implementation.

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[1] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

[2] In Water Right Decision 1641 (revised March 15, 2000), the State Water Board allocated responsibility for meeting the SJR flow objectives in the 1995 Bay-Delta Plan to the U.S. Bureau of Reclamation.

- LSJR Alternative 3 would establish a range between 30 and 50 percent, with 40 percent as the starting percentage of unimpaired flow in the program of implementation.
- LSJR Alternative 4 would establish a range between 50 and 60 percent, with 60 percent as the starting percentage of unimpaired flow in the program of implementation.

As described in more detail in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 would also include adaptive implementation intended to foster coordinated and adaptive management of flows based on best available scientific information in order to protect fish and wildlife beneficial uses. Adaptive implementation could also optimize flows to achieve the objective, while allowing for consideration of other beneficial uses, provided that these other beneficial uses do not reduce intended benefits to fish and wildlife.

There are four methods of adaptive implementation, detailed in Chapter 3, which allow for an adjustment of the volume of water required under LSJR Alternatives 2, 3, and 4. In general, the methods are as follows: method 1, increasing or decreasing the percent of unimpaired flow required by 10 percent depending on the LSJR alternative selected; method 2, adjusting the percent of unimpaired flow either within or between the months of February–June; method 3, adjusting the percent of unimpaired flow outside of February–June depending on the LSJR alternative selected; and method 4, maintaining a certain base flow in the San Joaquin River (SJR) at Vernalis at all times during the February–June period. The operational changes made using the adaptive implementation methods above may be approved if the best available scientific information indicates that the changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any biological goals. The changes may take place on either a short-term (e.g., monthly or annually) or a longer-term basis.

The Stanislaus, Tuolumne and Merced Working Group (STM Working Group) will assist with implementation, monitoring, and assessment activities for the unimpaired flow objectives and with developing biological goals to help evaluate the effectiveness of the unimpaired flow objectives and adaptive implementation actions.

The SDWQ alternatives, simply stated, are as follows.

- SDWQ Alternative 1, which is the No Project Alternative, would be a continuation of full compliance with the 2006 Bay-Delta Plan and the existing salinity objective in the plan (1.0 deciSiemens per meter [dS/m] September–March and 0.7 dS/m April–August in the southern Delta). It would also include continued conditioning of the U.S. Bureau of Reclamation (USBR) water rights at New Melones Dam to meet the water quality objective for salinity on the SJR at Vernalis (0.7 dS/m) and continued use of the temporary agricultural barriers in the southern Delta.
- SDWQ Alternative 2 would establish an annual 1.0 dS/m salinity objective for the southern Delta and include continued conditioning of USBR water rights to meet its current D-1641 salinity compliance requirement at Vernalis; allow for continued use of the temporary agricultural barriers; and establish various study, planning, and monitoring requirements.

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[3] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

- SDWQ Alternative 3 would establish an annual 1.4 dS/m salinity objective for the southern Delta and include continued conditioning of USBR water rights to meet its current D-1641 salinity compliance requirement at Vernalis; allow for continued use of the temporary agricultural barriers; and establish various study, planning, and monitoring requirements.

Details of these three SDWQ alternatives are provided in Chapter 3, *Alternatives Description,* and the language of the amended water quality control plan is included in Appendix K, *Revised Water Quality Control Plan*.

Other alternatives that were considered but eliminated during the alternatives screening process are summarized in Chapter 3.

18.2 LSJR Alternatives Comparison

Table 18-1 summarizes the results of the CEQA significance analysis for each resource area and the LSJR alternatives in the plan area, as discussed in Chapters 5–15. Table 18-2 summarizes the results of the CEQA significance analysis for each resource area and the LSJR alternatives in the extended plan area, as discussed in Chapters 5–15. Table 18-3 summarizes the results of the CEQA significance analysis for each resource area as discussed in Chapters 5–15 and the LSJR alternatives by geography. Table 18-4 (at the end of the chapter) summarizes the impacts, without adaptive implementation, by resource and threshold. Table 18-5 summarizes those significance determinations for each resource area that change with the inclusion of adaptive implementation. Additional information regarding these impact determinations can be found in Chapters 5–15. Although adaptive implementation is part of each LSJR alternative, impacts without adaptive implementation are also disclosed because it is unknown whether and to what extent adaptive implementation would be employed. The alternatives comparison includes the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1). This alternative is analyzed in detail in Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*, and technical information is presented in Appendix D, *Evaluation of the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)*.

As shown in Table 18-1, the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would result in significant impacts on water quality, aquatic biological resources, terrestrial biological resources, agricultural resources, cultural resources, service providers, and energy and greenhouse gases.

LSJR Alternatives 2 would not result in significant and unavoidable impacts. LSJR Alternative 2, with adaptive implementation, would result in significant and unavoidable impacts on groundwater resources, agricultural resources, and service providers. In the extended plan area, LSJR Alternative 2, with adaptive implementation, could also result in significant and unavoidable impacts on aquatic biological resources, terrestrial biological resources, recreational resources and aesthetics, and energy and greenhouse gases.

Several significant and unavoidable impacts on various resources were identified for LSJR Alternative 3. LSJR Alternative 3 would result in significant and unavoidable impacts on groundwater resources, agricultural resources, service providers, and energy and greenhouse gases. LSJR Alternative 3, with adaptive implementation, would also result in significant and unavoidable impacts on recreational resources. In the extended plan area, LSJR Alternative 3, with or without adaptive implementation, could also result in significant and unavoidable impacts on aquatic biological resources, terrestrial biological resources, recreational resources and aesthetics, and energy and greenhouse gases.

Several significant and unavoidable impacts on various resources were identified for LSJR Alternative 4. LSJR Alternative 4, with or without adaptive implementation, would result in significant and unavoidable impacts on groundwater resources, recreational resources, agricultural resources, service providers, and energy and greenhouse gases. In the extended plan area, LSJR Alternative 4, with or without adaptive implementation, could also result in significant and unavoidable impacts on aquatic biological resources, terrestrial biological resources, recreational resources and aesthetics, and energy and greenhouse gases.

Table 18-1. Summary of CEQA Significance Determinations in Chapters 5–15

Environmental Resource Area	No Project Alternative (LSJR /SDWQ Alternative 1)	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Without AI	With AI (30%)	Without AI	With AI (30%, 50%)	Without AI	With AI (50%)
Surface Hydrology and Water Quality	S	L	L	L	L	L	L
Flooding, Sediment, and Erosion	L	L	L	L	L	L	L
Aquatic Biological Resources	S	L	L	L	L	L	L
Terrestrial Biological Resources	S	L	L	L	L	L	L
Groundwater Resources	L	L	SU	SU	SU	SU	SU
Recreational Resources and Aesthetics	S	L	L	L	SU	SU	SU
Agricultural Resources	S	L	SU	SU	SU	SU	SU
Cultural Resources	S	L	L	L	L	L	L
Service Providers	S	L	SU	SU	SU	SU	SU
Energy and Greenhouse Gases	S	L	L	SU	SU	SU	SU

Note: Gray shading denotes a change in the significance determination for a resource between an alternative without adaptive implementation and with adaptive implementation.

AI = Adaptive implementation as described in Chapter 3, *Alternatives Description.* (%) reflects the maximum or minimum percent of unimpaired flow allowed under adaptive implementation method 1. If there is a change in significance determinations with and without adaptive implementation, it is because of this method.

S = significant impact

SU = significant and unavoidable impact

L = less-than-significant impact

N = no impact

Table 18-2. Summary of CEQA Significance Determinations for LSJR Alternatives 2, 3, and 4 in Chapters 5–14—Extended Plan Area

	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
Environmental Resource Area	Without AI	With AI (30%)	Without AI	With AI (30%, 50%)	Without AI	With AI (50%)
Surface Hydrology and Water Quality	L	L	L	L	L	L
Flooding, Sediment, and Erosion	L	L	L	L	L	L
Aquatic Biological Resources	L	SU	SU	SU	SU	SU
Terrestrial Biological Resources	L	SU	SU	SU	SU	SU
Groundwater Resources	L	L	L	L	L	L
Recreational Resources and Aesthetics	L	SU	SU	SU	SU	SU
Agricultural Resources	L	L	L	L	L	L
Cultural Resources	L	L	L	L	L	L
Service Providers	L	SU	SU	SU	SU	SU
Energy and Greenhouse Gases	L	SU	SU	SU	SU	SU

Notes:
The impact determinations in this table are for the extended plan area. The No Project Alternative is not included in this table because it would have no effect in the extended plan area. The SDWQ alternatives are not included in this table because they would have no effect in the extended plan area.

Gray shading denotes a change in the significance determination for a resource between the plan area and extended plan area.

AI = Adaptive implementation as described in Chapter 3, *Alternatives Description.* (%) reflects the maximum or minimum percent of unimpaired flow allowed under adaptive implementation method 1. If there is a change in significance determinations with and without adaptive implementation, it is because of this method.

SU = significant and unavoidable impact

L = less-than-significant impact

N = no impact

Table 18-3. Summary of LSJR Alternatives CEQA Significance Analysis by Geography in Chapters 5–15

Environmental Resource Area	No Project Alternative (LSJR /SDWQ Alternative 1)	LSJR Alternative 2 Without AI	LSJR Alternative 2 With AI (30%)	LSJR Alternative 3 Without AI	LSJR Alternative 3 With AI (30%, 50%)	LSJR Alternative 4 Without AI	LSJR Alternative 4 With AI (50%)
River and Reservoir Geography							
Surface Hydrology and Water Quality							
Stanislaus	L	L	L	L	L	L	L
Tuolumne	L	L	L	L	L	L	L
Merced River	S	L	L	L	L	L	L
Lower San Joaquin and Southern Delta	L	L	L	L	L	L	L
New Melones	L	L	L	L	L	L	L
New Don Pedro	L	L	L	L	L	L	L
Lake McClure	L	L	L	L	L	L	L
Flooding, Sediment, and Erosion							
Stanislaus	L	L	L	L	L	L	L
Tuolumne	L	L	L	L	L	L	L
Merced River	L	L	L	L	L	L	L
Lower San Joaquin and Southern Delta	L	L	L	L	L	L	L
Aquatic Biological Resources							
Stanislaus	S	L	L	L	L	L	L
Tuolumne	L	L	L	L	L	L	L
Merced River	S	L	L	L	L	L	L
Lower San Joaquin and Southern Delta	L	L	L	L	L	L	L
New Melones	S	L	L	L	L	L	L
New Don Pedro	L	L	L	L	L	L	L
Lake McClure	S	L	L	L	L	L	L

Environmental Resource Area	No Project Alternative (LSJR /SDWQ Alternative 1)	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Without AI	With AI (30%)	Without AI	With AI (30%, 50%)	Without AI	With AI (50%)
Terrestrial Biological Resources							
Stanislaus	L	L	L	L	L	L	L
Tuolumne	L	L	L	L	L	L	L
Merced River	S	L	L	L	L	L	L
Lower San Joaquin and Southern Delta	L	L	L	L	L	L	L
New Melones	L	L	L	L	L	L	L
New Don Pedro	L	L	L	L	L	L	L
Lake McClure	L	L	L	L	L	L	L
Recreational Resources and Aesthetics							
Stanislaus	L	L	L	L	SU	SU	SU
Tuolumne	L	L	L	L	SU	SU	SU
Merced River	L	L	L	L	L	L	L
Lower San Joaquin	L	L	L	L	L	L	L
New Melones	S	L	L	L	L	L	L
New Don Pedro	L	L	L	L	L	L	L
Lake McClure	L	L	L	L	L	L	L
Cultural Resources							
Stanislaus	L	L	L	L	L	L	L
Tuolumne	L	L	L	L	L	L	L
Merced River	L	L	L	L	L	L	L
Lower San Joaquin	L	L	L	L	L	L	L
New Melones	S	L	L	L	L	L	L
New Don Pedro	L	L	L	L	L	L	L
Lake McClure	L	L	L	L	L	L	L

Environmental Resource Area	No Project Alternative (LSJR /SDWQ Alternative 1)	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Without AI	With AI (30%)	Without AI	With AI (30%, 50%)	Without AI	With AI (50%)
Service Providers							
Stanislaus	L	L	L	SU	SU	SU	SU
Tuolumne	L	L	SU	SU	SU	SU	SU
Merced River	L	L	SU	SU	SU	SU	SU
Southern Delta	S	L	L	L	L	L	L
River and Groundwater Subbasin Geography							
Groundwater Resources							
Stanislaus River - Eastern San Joaquin Subbasin	L	L	L	L	L	SU	SU
Stanislaus River and Tuolumne River - Modesto Subbasin	L	L	L	SU	SU	SU	SU
Tuolumne River - Turlock Subbasin	L	L	L	SU	SU	SU	SU
Merced River - Extended Merced Subbasin[a]	L	L	SU	SU	SU	SU	SU
River, Irrigation District and Agricultural Geography							
Agricultural Resources							
Stanislaus River - Stockton East Water District/Central San Joaquin Water Conservation District	S	L	L	L	L	L	L
Stanislaus River - South San Joaquin Irrigation District	S	L	L	SU	SU[b]	SU	SU
Stanislaus River - Oakdale Irrigation District	S	L	SU	SU	SU	SU	SU
Tuolumne River - Modesto Irrigation District	L	L	SU	SU	SU	SU	SU
Tuolumne River - Turlock Irrigation District	L	L	L	SU	SU[b]	SU	SU

Environmental Resource Area	No Project Alternative (LSJR /SDWQ Alternative 1)	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
		Without AI	With AI (30%)	Without AI	With AI (30%, 50%)	Without AI	With AI (50%)
Merced River - Merced Irrigation District	L	L	L	L	L	L	SU

Notes:

Energy and greenhouse gases are not included in this table because while changes on each river were calculated, potential impacts associated with these resources (impacts on the California electric grid and global climate change) would affect a larger region.

Gray shading denotes a determination of a significant impact for a resource under a particular alternative.

AI = Adaptive implementation as described in Chapter 3, Alternatives Description. (%) reflects the maximum or minimum percent of unimpaired flow allowed under adaptive implementation method 1. If there is a change in significance determinations with and without adaptive implementation, it is because of this method.

S = significant impact

SU = significant and unavoidable impact

L = less-than-significant impact

N = no impact

[a] As described in Chapter 9, *Groundwater Resources*, northern portion of the Chowchilla Subbasin is combined with the Merced Subbasin because the small area between the Merced Subbasin and the Chowchilla River is part of the surface water delivery area for the Merced River.

[b] Impact would be less than significant at 30% unimpaired flow.

Table 18-5. Impact Determinations that Change with Adaptive Implementation (LSJR Alternatives 2 and 3) [a,b]

Impact	Without Adaptive Implementation	With Adaptive Implementation[c,d]
Chapter 9: Groundwater Resources—LSJR Alternative 2		
Impact GW-1: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge	Less than significant— The average annual groundwater balance is expected to be reduced by less than the equivalent of 1 inch across each of the subbasins. This is not expected to produce a measurable decrease in groundwater elevations. Therefore, there would not be a substantial depletion of groundwater supplies or substantial interference with groundwater recharge.	Significant and unavoidable— If adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%), it is expected that the average annual groundwater balance would be reduced by the equivalent of more than 1 inch across the Extended Merced Subbasin, thus producing an eventual measurable decrease in groundwater elevations. Therefore, it is expected that there would be a substantial depletion of groundwater supplies or substantial interference with groundwater recharge in this subbasin under LSJR Alternative 2.
Impact GW-2: Cause subsidence as a result of groundwater depletion	Less than significant—The average annual groundwater balance is expected to be reduced by less than the equivalent of 1 inch across each of the subbasins. This is not expected to produce a measurable decrease in groundwater elevations or associated subsidence.	Significant and unavoidable— If adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%), the average annual groundwater balance could potentially be reduced by the equivalent of more than 1 inch across the Extended Merced Subbasin. If this occurred, it could worsen subsidence that is already occurring in this subbasin. Therefore, subsidence could potentially significantly increase under LSJR Alternative 2.
Chapter 11: Agricultural Resources—LSJR Alternative 2		
Impact AG-1: Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use	Less than significant— Conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses is not expected because potential reductions in surface water diversions would result in less than 4% average reduction in irrigated acreage for the irrigation districts in the LSJR area of potential effects.	Significant and unavoidable— If adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%), environmental impacts would be potentially significant and unavoidable as it is estimated that OID could experience a 4.4% average reduction in irrigated crops, which equates to 2,356 acres receiving reduced irrigation, and MID could experience a 4.5% average reduction in irrigated crops, which equates to 2,589 acres receiving reduced irrigation. It is

Impact	Without Adaptive Implementation	With Adaptive Implementation^c,d^
		reasonable to assume that a portion of the reduced irrigated acreage is Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, and that some portion of acreage with reduced irrigation could potentially be converted to nonagricultural uses even though there are many factors affecting whether land is converted. Conversely, land can be maintained in agricultural use through crop substitution, crop rotation, fallowing, and dry land farming.
Chapter 10: Recreational Resources and Aesthetics—LSJR Alternative 3		
Impact REC-1: Substantially physically deteriorate existing recreational facilities on the rivers or at the reservoirs	Less than significant—Modeled frequencies of flows greater than 2,500 cfs would change little on the Stanislaus and Merced Rivers, and therefore on-bank recreational facilities would not experience substantially more inundation relative to baseline conditions. However, flows greater than 2,500 cfs would increase in frequency on the Tuolumne River in May and June, but would remain close to baseline values July – September. Although the flows on the Tuolumne River could result in an increase in the frequency of inundation of on-bank recreation areas during May and June, recreational facilities are not anticipated to substantially physically deteriorate along the river. On-bank recreational facilities are built to withstand periodic inundation with higher river flows.	Significant and unavoidable— If adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 40% up to 50%), it is expected that the modeled seasonal average frequency of river flows above 2,500 cfs on the Tuolumne River would greatly increase, especially during May and June. The frequency of inundation of on-bank facilities on the Tuolumne River and, to a lesser extent, on the Stanislaus River is expected to increase compared to baseline and result in substantial deterioration of existing recreational facilities.
Chapter 13: Service Providers—LSJR Alternative 2		
Impact SP-1: Require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.	Less than significant—Average surface water diversions on the Stanislaus, Tuolumne, and Merced Rivers would be reduced by 2%, 2%, and 6%, respectively, compared to baseline conditions, and there would not be a substantial depletion of groundwater supplies. Therefore, it is not expected that service providers or public water suppliers would need to construct or operate new wastewater treatment facilities or water supply	Significant and unavoidable—If adaptive implementation method 1 were implemented on a long-term basis (an increase in the February–June percent of unimpaired flow from 20% up to 30%) it is expected that there would be a substantial reduction in the water supply on the Tuolumne and Merced Rivers of approximately 7%, and 10%, respectively, and a substantial depletion of groundwater supplies in the Extended Merced Subbasin. These reductions would potentially require service

Impact	Without Adaptive Implementation	With Adaptive Implementation[c,d]
	facilities or infrastructure.	providers to construct new or expanded water supply or wastewater treatment facilities, which could result in significant and unavoidable environmental impacts.
Impact SP-2b: Violate any water quality standards such that drinking water quality from domestic wells would be affected.[e]	Less than significant—Because service providers and irrigation districts relying primarily on surface water would not need to supplement their supply with groundwater under LSJR Alternative 2, there would likely be no degradation of groundwater quality.	Significant and unavoidable—If an increase in the February–June percent of unimpaired flow from 20% up to 30% were implemented on a long-term basis, increased groundwater pumping and reductions in groundwater levels in the Extended Merced Subbasin could affect groundwater quality. Domestic well users are largely unregulated and are not subject to any state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. There is no required mechanism to prevent private domestic wells from using groundwater that may exceed Maximum Contaminant Levels.

[a] The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) and SDWQ Alternatives 2 and 3 have no adaptive implementation and therefore are not included in this table.

[b] As discussed in Section 18.2.1, *Summary of Alternatives Impact Analysis*, there are no differences in the impact determinations between LSJR Alternative 4 with the inclusion of adaptive implementation, and as such, it is not included in this table.

[c] Four adaptive implementation methods could occur under the LSJR alternatives, as described in Chapter 3, *Alternatives Description*, and summarized in the Chapters 9, 11, and 13 *Methods and Approach* sections.

[d] Implementing adaptive implementation method 1 on a more frequent basis can result in a change in the impact determination for LSJR Alternative 2, as analyzed in Chapters 9, 11, and 13 and LSJR Alternative 3, as analyzed in Chapters 10.

[e] Salinity in the SJR at Vernalis and in the southern Delta is not relevant to groundwater and drinking water quality from domestic wells and, therefore, there would be no impact from the changes in salinity in these surface waters, and this is not discussed further in Impact SP-2b.

18.2.1 Summary of Alternatives Impact Analysis

Overall, LSJR alternatives (e.g., LSJR Alternative 2, without adaptive implementation) that require similar unimpaired flows when compared to baseline on the three eastside tributaries[4] have less-than-significant impacts on resources that require or are dependent on surface water diversion. These resources include agricultural resources, groundwater resources, service providers, and energy and greenhouse gases. Overall, LSJR alternatives (e.g., LSJR Alternative 4, with adaptive implementation) that could require higher percentages of unimpaired flows when compared to baseline conditions on all three eastside tributaries have less-than-significant impacts on resources requiring or relying on flow, such as surface hydrology, water quality; aquatic biological resources; and terrestrial biological resources.

Generally, the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would result in lower flows on the Merced River and less surface water diversion on the Stanislaus River when compared to baseline (see Chapter 15, *No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1,* for impact analysis and Appendix D, *Evaluation of the No Project Alternative [LSJR Alternative 1 and SDWQ Alternative 1]* for technical assumptions and results). This would result in significant impacts on resources requiring or relying on flow in the river(s) or relying on surface water diversions. Specifically, there would be significant impacts on water quality; aquatic biological resources; terrestrial biological resources; agricultural resources; recreational resources, cultural resources, service providers; and energy and greenhouse gases. Thus, the alternative that results in a continuation of, and full compliance with, the existing 2006 Bay-Delta Plan would not avoid significant environmental impacts.

Generally, LSJR Alternative 2 would result in flows similar to, or slightly greater than, baseline conditions on the three eastside tributaries. This alternative would result in less-than-significant impacts on all resources. However, if adaptive implementation method 1 is implemented long-term and the percent of unimpaired flow is increased from 20 to 30, then significant and unavoidable impacts would occur to resources that require water for beneficial uses other than fish and wildlife, such as groundwater resources, agricultural resources and service providers.

LSJR Alternatives 3 or 4, with or without adaptive implementation, generally require higher flow on the Stanislaus, Tuolumne, and Merced Rivers when compared to baseline. Thus, these alternatives result in significant and unavoidable impacts on resources that require water for uses other than fish and wildlife, such as agricultural resources, service providers, and energy and greenhouse gases. These alternatives would also result in significant and unavoidable impacts on groundwater resources because of the average annual groundwater balance is expected to be reduced by less than the equivalent of 1 inch across each of the four primary subbasins, which could produce a measurable decrease in groundwater elevations and substantially deplete groundwater supplies. In addition, LSJR Alternative 3, with adaptive implementation, and LSJR Alternative 4, with or without adaptive implementation, would have significant and unavoidable impacts on recreational resources because of increased flows on the eastside tributaries that would result in more frequent inundation of on-bank recreational facilities.

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[4] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

Construction and operation of different facilities could occur in the plan area or extended plan area as a result of either indirect actions that entities could take as a result of the LSJR alternatives or as a result of implementing non-flow measures in order to inform the body of scientific information potentially used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4. The construction and operation of these facilities could involve impacts on different resources (summarized in Tables 18-6 and 18-7). While many of these activities would result in no impacts or less-than-significant impacts on different resources, it primarily depends on the location of the activity, the duration of the activity, and the ability of a lead agency to mitigate potential significant impacts as to whether activities would result in no impacts or significant and unavoidable impacts, as described below in Section 18.2.2, *Significant and Unavoidable Impacts.*

18.2.2 Significant and Unavoidable Impacts

Generally, the contribution of the LSJR alternatives to significant and unavoidable impacts depends on the percent of unimpaired flow required and the number of rivers, reservoirs, groundwater subbasins, or irrigation districts affected. It also depends on whether the percent of unimpaired flow would be adjusted through adaptive implementation on a more frequent basis or a longer duration to a higher or lower unimpaired flow (i.e., adaptive implementation method 1). As such, generally lower flows that may be adjusted more frequently and for longer periods of time may result in a smaller contribution to a significant and unavoidable impact when compared to higher flows that may be adjusted less frequently.

Surface Hydrology and Water Quality

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative) would result in significant impacts on water quality because the flows on the Merced River would be reduced when compared to baseline (especially during drier years and in April and May), thereby potentially increasing the pollutant concentrations.

Aquatic Biological Resources

LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative) would result in significant impacts on aquatic biological resources on the Merced and Stanislaus Rivers and at New Melones Reservoir and Lake McClure. Flows on the Merced River would be reduced when compared to baseline (especially during drier years and in key months of April and May), thereby increasing temperatures for aquatic species, as well as increasing the risk of disease and exposure to pollutants and predation. Significant impacts would also occur on the Stanislaus River because higher summer and fall release temperatures associated with reduced storage in New Melones Reservoir would increase the frequency of stressful water temperatures, as well as increasing the risk of disease and exposure to pollutants and predation. Reservoir water levels at New Melones Reservoir and Lake McClure would substantially fluctuate April–September, such that spawning success and habitat availability for warmwater species would be significantly reduced. Furthermore, at New Melones, given the end-of-September changes in storage, coldwater species reservoir habitat would also be significantly affected.

In the extended plan area, LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, could also result in significant and unavoidable impacts on aquatic biological resources. This is because of potential loss, or substantial decrease, in suitable habitat (including temperature) in existing reservoirs and rivers, particularly on the Stanislaus and Tuolumne Rivers.

Terrestrial Biological Resources

LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative) would result in significant impacts on terrestrial biological resources, particularly riparian habitat and those terrestrial species relying on riparian habitat, because the flows on the Merced River would be reduced when compared to baseline (especially during drier years and potentially in the spring), thereby reducing riparian habitat that is currently limited under baseline.

In the extended plan area, LSJR Alternatives 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, could also result in significant and unavoidable impacts on terrestrial biological resources. This is because of potential loss, or substantial decrease in, habitat at existing reservoirs and on rivers, particularly on the Stanislaus and Tuolumne Rivers.

Groundwater Resources

LSJR Alternative 2, with adaptive implementation, would have significant and unavoidable impacts on groundwater resources. The magnitude of the significance is related to the amount of expected groundwater pumping needed to replace the lost surface water diversions under each of the alternatives. There would be a higher magnitude of pumping expected in the Extended Merced Subbasin when compared to the three other subbasins evaluated. It is expected that the average annual groundwater balance would be reduced by the equivalent of more than 1 inch across the Extended Merced Subbasin, thus producing an eventual measurable decrease in groundwater elevations. Therefore, it is expected that there would be a substantial depletion of groundwater supplies or substantial interference with groundwater recharge in this subbasin.

LSJR Alternatives 3 and 4, with or without adaptive implementation, would have significant and unavoidable impacts on groundwater resources. Similar to LSJR Alternative 2, with adaptive implementation, the average annual groundwater balance would be reduced, producing eventual measureable decrease across multiple subbasins. These subbasins include: Eastern San Joaquin, Modesto, Turlock, and Extended Merced.

LSJR Alternative 2, with adaptive implementation, is expected to have the smallest contribution of the alternatives that have significant and unavoidable impacts on groundwater resources because less groundwater is expected to be pumped and because only the Extended Merced Subbasin is affected.

Recreational Resources and Aesthetics

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative) would result in significant impacts on recreation and aesthetics because the elevation levels of New Melones Reservoir would be substantially reduced more frequently and visual quality of the reservoir would be degraded, thereby affecting recreational facilities (e.g., boat ramps) and the visual character and quality of the reservoir.

There are significant and unavoidable impacts on recreational resources for LSJR Alternative 3, with adaptive implementation, and LSJR Alternative 4, with or without adaptive implementation. It is expected that the modeled seasonal average frequency of river flows above 2,500 cubic feet per second (cfs) on the Tuolumne River would greatly increase, especially during May and June, under LSJR Alternative 3, with adaptive implementation, and on the Stanislaus and Tuolumne Rivers, under LSJR Alternative 4, with adaptive implementation. Thus, the frequency of inundation of on-bank facilities would be substantially more, when compared to baseline, particularly in May and June, during the recreational season. As such, implementation of LSJR Alternative 3, with adaptive implementation and LSJR Alternative 4, with or without adaptive implementation, could substantially physically deteriorate existing recreational facilities.

In the extended plan area, LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, could also result in significant and unavoidable impacts on recreational resources and aesthetics. This is because of potential significant reductions in reservoir elevation and river levels, particularly on the Stanislaus and Tuolumne Rivers, in areas frequently used by recreationists or that are designated as wild and scenic rivers or areas that are along designated state scenic highways.

Agricultural Resources

Significant impacts on agricultural resources would result from the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) because the flow would be increased on the Stanislaus River when compared to baseline to comply with the 2006 Bay-Delta Plan, and surface water diversions that are currently used to irrigate Prime, Unique, and Farmland of Statewide Importance lands would be reduced. As such, it is anticipated that a substantial reduction in crop acreage would occur in irrigation districts (i.e., Stockton East Water District/Central San Joaquin Water Conservation District, South San Joaquin Irrigation District [SSJID], and Oakdale Irrigation District [OID]) that rely on Stanislaus surface water, and these types of farmland could potentially be converted to nonagricultural uses.

LSJR Alternative 2, with adaptive implementation, would experience a reduction in surface water diversions that are currently used to irrigate Prime, Unique, and Farmland of Statewide Importance lands. As such, it is anticipated that substantial reduction in crop acreage would occur in the Modesto Irrigation District (MID) that relies on Tuolumne River surface water, and Oakdale Irrigation District (OID) that relies on Stanislaus River surface water. As such, these types of farmland could potentially be converted to nonagricultural uses.

LSJR Alternatives 3 and 4, with or without adaptive implementation, would also experience a reduction in surface water diversions on the Stanislaus, Tuolumne, and Merced Rivers that are currently used to irrigate Prime, Unique, and Farmland of Statewide Importance lands. As such, it is anticipated that a substantial reduction in crop acreage could occur in more irrigation districts that rely on surface water from the three eastside tributaries when compared to LSJR Alternative 2 (i.e. SSJID, OID, TID, MID, and Merced Irrigation District). As such, these types of farmland could be converted to nonagricultural uses.

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1), and LSJR Alternative 2, with adaptive implementation, would have the smallest contribution of the other alternatives that have significant and unavoidable impacts on agricultural resources because it is expected that any potential conversion of agricultural land to nonagricultural land would only occur within those areas served by Stanislaus River water (i.e., SEWD/CSJWCD, SSJID, and OID) or Tuolumne River surface water (i.e., MID) and Stanislaus River surface water (i.e., OID), whereas under LSJR Alternatives 3 or 4, with or without adaptive implementation, more irrigation districts could potentially experience a conversion of designated farmland to nonagricultural lands.

Cultural Resources

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would result in significant impacts on cultural resources because the end-of-September storage at New Melones Reservoir is anticipated to be greatly reduced in over half the years when compared to baseline. This would most likely expose cultural resources and could result in a substantial adverse change to the significance of existing cultural resources if they were disturbed by people or disturbed by another physical method (e.g., light, exposure).

Service Providers

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would result in significant impacts on service providers; LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, would result in significant and unavoidable impacts on service providers. This is because it is expected the increase in unimpaired flows on the rivers under the alternatives would result in a corresponding decrease in surface water diversions for other beneficial uses. As a result, service providers that rely on surface water supplies from the tributary rivers (e.g., TID, MID, City of Modesto, CCSF, and Merced ID under LSJR Alternative 2 with adaptive implementation and TID, MID, City of Modesto, CCSF, Merced ID, SSJID, OID, City of Tracy, and SEWD under LSJR Alternatives 3 and 4 with or without adaptive implementation) may have to construct new or expanded water treatment facilities or water supply infrastructure, the construction of which could cause significant environmental effects on other resources (e.g., aesthetics, terrestrial or aquatic biological resources, cultural resources, etc.). In addition, service providers that rely on groundwater in the Extended Merced Subbasin under LSJR Alternative 2 with adaptive implementation, the Merced, Modesto, Turlock Subbasins, and Eastern San Joaquin Subbasin for LSJR Alternative 3 with or without adaptive implementation may also need to construct new or expanded facilities. The need to construct new facilities depends on a variety of factors, including the size of the population being served and the number of active municipal wells in their service area, the range of differences between well depths and depths to groundwater, the physical condition of wells, and other factors.

As a result of increased groundwater pumping, reductions in groundwater levels in the Extended Merced Subbasin under LSJR Alternative 2, with adaptive implementation, in the Modesto, Turlock, and Extended Merced Subbasins under LSJR Alternative 3, with or without adaptive implementation, and also in the Easter San Joaquin Subbasin under LSJR Alternative 4, with or without adaptive implementation, could affect groundwater quality such that drinking water from domestic wells could be significantly affected. Domestic well users are largely unregulated and are not subject to any state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. There is no required mechanism to prevent private domestic wells from using groundwater that may exceed maximum contaminant levels (MCLs). Therefore, impacts would be significant and unavoidable.

In the extended plan area, LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, could also result in significant and unavoidable impacts on service providers (Table 13-6). This is similar to the impacts in the plan area and relate to the potential reductions in surface water supply. The reduction could result in construction of new or expanded water treatment facilities or water supply infrastructure, the construction of which could cause significant environmental effects on other resources.

Energy and Greenhouse Gases

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would have significant greenhouse gas impacts. LSJR Alternatives 3 and 4, with or without adaptive implementation, would have significant and unavoidable greenhouse gas impacts. The magnitude of the significance is related to the amount of hydropower reduced and potential groundwater that could be pumped to replace the lost surface water diversions under each of the alternatives. Compared to LSJR Alternatives 3 and 4, the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) is expected to have the smallest contribution on climate change because it is expected the groundwater pumping would take place as a result of the decrease in surface water diversions from the Stanislaus River alone, whereas LSJR Alternative 3 or 4, with or without adaptive implementation, would experience a decrease in surface water diversions from additional eastside tributaries (the Merced and Tuolumne Rivers).

In the extended plan area, LSJR Alternative 2, with adaptive implementation, and LSJR Alternatives 3 and 4, with or without adaptive implementation, could also result in significant and unavoidable impacts on energy and greenhouse gases. This is because of potential changes to surface water elevations of reservoirs on the Stanislaus and Tuolumne Rivers.

Indirect Actions and Non-Flow Measures

The evaluation contained in Chapter 16, *Evaluation of Other Indirect and Additional Actions,* provides a discussion of other indirect actions and additional actions associated with LSJR Alternatives 2, 3, and 4. The actions include those that the regulated community could take to reduce potential reservoir or water supply effects associated with implementing LSJR Alternatives 2, 3, and 4 or that would inform the body of scientific information potentially used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4 (i.e., non-flow measures). This subsection presents a suite of reasonably foreseeable actions that affected entities may undertake to address possible surface water supply reductions anticipated under LSJR Alternatives 2, 3, and 4 and analyzes the indirect environmental impacts associated with those actions. The combination of the different types of additional actions and other indirect actions that entities could take in response to each of the alternatives is unknown. While entities could take one or more of these actions, the combination of actions taken under each alternative is speculative and cannot be predictably aligned with each alternative. As such, the summary tables below (Tables 18-6 and 18-7) focus on the actions (discussed primarily in Chapter 16) that agencies or entities could undertake as a result of each alternative, without specifically assigning the actions to a particular alternative.

In many cases, the evaluations of actions presented in Chapter 16 include both construction and operation impacts. In cases with both construction and operation, the summary tables reflect the highest level of impact, which is generally construction-related. The determinations are post-mitigation level of significance. Potential mitigation measures are proposed in Chapter 16 to reduce potentially significant impacts; however, the particular circumstances of the actions and appropriate mitigation measures would be project specific. In addition, as required by CEQA (State CEQA Guidelines § 15126.2) lead agencies would describe a reasonable range of alternatives based on project-specific conditions and project-specific objectives, and one of the project-specific alternatives may in and of itself reduce significant environmental impacts. A project-specific alternative could be selected as a proposed project. The effectiveness of mitigation is contingent upon several other factors, such as those listed below.

- The ability of lead agencies or other entities to implement the mitigation.

- The other responsible agencies involved in the project.
- The thresholds lead agencies use to evaluate the impact.
- Site-specific conditions.

Lead agencies or other entities with discretionary approval authority can and should impose the relevant mitigation measures identified in Tables 16-38 and 16-39. However, depending on project specifics, implementing mitigation measures may not be fully able to reduce significant impacts, and such impacts may remain significant and unavoidable after mitigation. Until such time that potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. The summary tables reflect this.

Table 18-6. CEQA Significance Summary of LSJR Alternatives—Other Indirect Actions

Environmental Resource Area	Transfer of Surface Water	Substitution with Groundwater	Aquifer Storage and Recovery	Recycled Water Sources for Water Supply	In-Delta Diversion	Water Supply Desalination	New Surface Water Supplies
Aesthetics	SU	**SU***	N	**SU***	**SU***	**SU***	SU
Agriculture and Forestry Resources	SU	**L**	L	**SU***	**SU***	**SU***	SU
Air Quality	L	**SU***	L	**SU***	**SU***	**SU***	**SU**
Biological Resources	SU	**SU***	L	**SU***	**SU***	SU	SU
Cultural Resources	L	**SU***	L	**SU***	**SU***	**SU***	**SU**
Geology and Soils	L	**SU***	N	**SU***	**SU***	**SU***	**SU***
Greenhouse Gas Emissions	L	SU	L	SU	SU	SU	SU
Hazards and Hazardous Materials	L	**SU***	N	**SU***	**SU***	**SU***	**SU***
Hydrology and Water Quality	SU	**SU***	L	**SU***	**SU***	SU	**SU***
Land Use and Planning	L	L	L	L	L	**SU***	L
Mineral Resources	L	**N**	L	**L**	**L**	**N**	**SU**
Noise	N	**SU***	N	**SU**	**SU***	**SU***	**SU**
Population and Housing	N	**L**	N	**N**	**L**	**N**	**L**
Public Services	L	**N**	N	**N**	**L**	**SU***	SU
Recreation	SU	**N**	N	**L**	**L**	**SU***	**SU**
Transportation and Traffic	L	**SU***	L	**SU***	**SU***	**SU***	SU
Utilities and Service Systems	L	SU	N	SU	SU	SU	SU

Notes:

Bold text indicates primarily construction-driven impacts. Operation-driven impacts are not bold.

* Indicates that the impact after mitigation may be less than significant; however, given the various factors influencing the potential implementation of mitigation, and until such time that mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

SU = significant and unavoidable impact

L = less-than-significant impact

N = no impact

Table 18-7. CEQA Significance Summary of LSJR Alternatives—Non-Flow Measures

Environmental Resource Area	Floodplain and Riparian Habitat Restoration	Reduce Vegetation-Disturbing Activities	Gravel Augmentation	Enhance In-Channel Complexity	Improve Temperature Conditions	Fish Passage Improvements – Fish Screens	Fish Passage Improvements – Physical Barriers in S. Delta	Fish Passage Improvements – Human-Made Barriers to Migration	Predatory Fish Control	Invasive Vegetation Control
Aesthetics	**L**	N	**L**	**L**	**SU***	**L**	**L**	N	**L**	L
Agriculture and Forestry Resources	**SU**	N	**N**	**N**	**N**	**N**	**L**	N	**N**	N
Air Quality	**SU***	N	**SU***	**SU***	**SU***	**SU***	**SU***	L	**SU***	L
Biological Resources	**SU***	N	**SU***	**SU**	**SU***	**SU**	**SU**	L	**SU**	SU*
Cultural Resources	**SU***	N	**L**	**SU***	SU	**SU***	**SU***	N	**SU***	L
Geology and Soils	**SU***	N	**SU***	**SU***	**L**	**SU***	**SU***	N	**N**	N
Greenhouse Gas Emissions	SU	L	SU	SU	SU	SU	SU	L	SU	SU
Hazards and Hazardous Materials	**SU***	N	**SU***	**SU***	**SU***	**SU***	**SU***	N	**SU***	SU*
Hydrology and Water Quality	**SU***	N	**SU***	**SU***	**SU***	**SU***	**SU***	N	**SU***	SU*
Land Use and Planning	**N**	N	**N**	**N**	**L**	**L**	**L**	N	**L**	N
Mineral Resources	**L**	N	SU	**L**	**N**	**N**	**N**	N	**N**	N
Noise	**L**	N	**L**	**L**	**SU***	**SU**	**SU***	N	**SU***	L
Population and Housing	**N**	N	**N**	**N**	**N**	**N**	**N**	N	**N**	N
Public Services	**N**	N	**N**	**N**	**N**	**N**	**N**	N	**N**	N
Recreation	**L**	N	**L**	**L**	**N**	**N**	**SU***	N	**L**	L

Environmental Resource Area	Floodplain and Riparian Habitat Restoration	Reduce Vegetation-Disturbing Activities	Gravel Augmentation	Enhance In-Channel Complexity	Improve Temperature Conditions	Fish Passage Improvements – Fish Screens	Fish Passage Improvements – Physical Barriers in S. Delta	Fish Passage Improvements – Human-Made Barriers to Migration	Predatory Fish Control	Invasive Vegetation Control
Transportation and Traffic	**SU***	N	**N**	**L**	**L**	**L**	**L**	N	**L**	L
Utilities and Service Systems	**N**	N	**N**	**N**	**N**	**N**	**N**	N	**N**	N

Note:

Bold text indicates primarily construction-driven impacts. Operation-driven impacts are not bold.

* Indicates that the impact after mitigation may be less than significant; however, given the various factors influencing the potential implementation of mitigation, and until such time that mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

SU = significant and unavoidable impact

L = less-than-significant impact

N = no impact

18.2.3 Environmentally Superior Alternative

CEQA requires a discussion of the environmentally superior alternative. If that alternative is the no project alternative, the environmental document shall also identify an environmentally superior alternative among the other alternatives. (Cal. Code Regs., tit. 14, § 15126.6(e).) In considering the selection of the environmentally superior alternative, this SED evaluates which alternatives result in fewer significant impacts relative to the other alternatives, and also considers whether those alternatives are feasible, taking into account economic, environmental, social, technological, and other factors. (Pub. Resources Code, §§ 21081(a)(3), 21061.1.) An agency may conclude that an alternative is infeasible, for example, if it is inconsistent with agency goals or policies or if it will not satisfy project objectives.

LSJR Alternatives

The No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would result in significant changes when compared to baseline conditions in Merced River flows (reduced flows) and Stanislaus River flows (increased flows). Therefore, the No Project Alternative is expected to result in significant impacts on Merced River resources such as aquatic biological resources, terrestrial biological resources, and recreational resources that rely on existing baseline flows because the flows would be reduced under No Project Alternative conditions. In addition, the No Project Alternative is expected to result in impacts on agricultural resources, service providers, and other resources that rely on surface water diversions from the Stanislaus River because surface water diversions would be reduced on the Stanislaus River to allow for the increase in flow. No Project Alternative conditions would be the same on the Tuolumne River and, therefore, would result in impacts that are less than significant. In sum, the No Project Alternative is not the environmentally superior alternative because it would not avoid impacts relative to the other alternatives (and, in fact, would result in more significant effects than the other alternatives). As discussed below, it also would not satisfy the purposes and goals of the plan amendments.

LSJR Alternative 2, without adaptive implementation, has no significant and unavoidable impacts when compared to the other LSJR alternatives, as baseline flows on the rivers are similar to the unimpaired flow (20 percent) that would be required by this alternative. As such, LSJR Alternative 2, without adaptive implementation, is the environmentally superior alternative because it has no significant and unavoidable environmental impacts. As discussed below, however, the alternative does not meet the purposes and goals of the proposed plan amendments. In addition, adaptive implementation is part of, and one of the goals of, the plan amendments.

Typically the type, magnitude, and severity of impacts from the LSJR alternatives would increase as the percent of unimpaired flow increases. LSJR Alternative 2, with adaptive implementation, has significant and unavoidable environmental impacts on three resources: groundwater resources, agricultural resources, and service providers. Impacts on these resources would primarily occur as a result of long-term implementation of adaptive implementation method 1 (increase to 30 percent unimpaired flow) and the reduction of surface water supply that could result in impacts on groundwater resources in one out of four subbasins (Extended Merced Subbasin); agricultural resources in two out of eight irrigation districts (MID and OID); and five service providers that rely on surface water diversions (TID, MID, City of Modesto, CCSF, and Merced ID). LSJR Alternatives 3 or 4, with or without adaptive implementation, generally result in impacts that are less than significant on those resources requiring or relying on flow (e.g., aquatic biological resources, terrestrial biological resources) but significant and unavoidable impacts on those resources that rely on surface water diversions (e.g., groundwater resources; recreation, agricultural resources; service providers; and energy and greenhouse gases). None of the LSJR alternatives would result in growth-inducing effects.

Generally, the LSJR alternatives, with adaptive implementation, all have significant and unavoidable impacts on the following resources in the extended plan area: aquatic biological resources, terrestrial biological resources, recreational resources and aesthetics, service providers, and energy and greenhouse gases. As such, there is very little difference between the LSJR alternatives. However, it is expected that the potential magnitude and severity of impacts on these resources would increase from LSJR Alternative 2 with adaptive implementation (i.e., 30 percent unimpaired flow) to LSJR Alternative 4 without adaptive implementation (i.e., 60 percent unimpaired flow). Under all LSJR alternatives, the program of implementation and the proposed mitigation measure (of considering carryover storage and other requirements to implement the flow water quality objectives in a water right proceeding to ensure that reservoir levels upstream of the rim dams[5] do not cause significant resource impacts, unless doing so would be inconsistent with applicable laws), could potentially reduce impacts on these resources. However, impacts are considered significant because mitigation may not fully mitigate impacts in all situations. Significant and unavoidable agricultural resource impacts in the plan area may be reduced if the extended plan area were affected because potentially more water could be used below the rim dams to irrigate agricultural resources; however, the extent of the offset and potential reduction of impacts is unknown until a water right proceeding occurs and the responsibility of meeting the approved unimpaired flow objectives is assigned.

Under all of the LSJR alternatives, indirect actions and non-flow measure could occur (as disclosed in Chapter 16, Section 18.2.2, and Tables 18-6 and 18-7). While implementation of indirect actions and non-flow measures may be less likely under certain LSJR alternatives (e.g., LSJR Alternative 2, with or without adaptive implementation, given this alternative is more similar to baseline conditions when compared to other LSJR alternatives), it cannot be predicted as to the number or type of actions that could occur under each LSJR alternative. The indirect actions and non-flow measures have been identified as having significant and unavoidable impacts. Since the potential combination of indirect actions and non-flow measures under the LSJR alternatives is unknown, so is the scope, magnitude, and location of the significant and unavoidable impacts. As such, it cannot be concluded that specific significant and unavoidable impacts would occur under one LSJR alternative when compared to another with respect to the indirect and non-flow actions.

In evaluating whether an alternative is feasible or infeasible, a lead agency may take into account a broad range of factors, including whether an alternative is inconsistent with agency goals or policies, meets the project objectives, and other considerations. The purpose and goals of the plan amendments (flow objectives and associated program of implementation), as described in Chapter 3, *Alternatives Description*, are as follows.

1. Maintain inflow conditions from the SJR Watershed sufficient to support and maintain the natural production of viable native fish populations migrating through the Delta.

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[5] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries—the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted.
3. Provide flows in a quantity necessary to achieve functions essential to native fishes such as increased floodplain inundation, improved temperature conditions, improved migratory conditions, and promote other conditions that favor native fishes over nonnative fishes.
4. Allow adaptive implementation of flows that will afford maximum flexibility in establishing beneficial habitat conditions for native fishes, addressing scientific uncertainty and changing conditions, developing scientific information that will inform future management of flows, and meeting biological goals, while still reasonably protecting the fish and wildlife beneficial uses.
5. Promote transparency in decision-making and provide certainty to the regulated community by expressing flow requirements for the protection of fish and wildlife as a share of the total quantity of water available for all beneficial uses.
6. In establishing flow water quality objectives to reasonably protect fish and wildlife, take into consideration all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.
7. Provide for the development and implementation of an appropriate monitoring and evaluation program to inform adaptive implementation of LSJR flows and future changes to the Bay-Delta Plan.
8. Provide for, and encourage, collaboration, coordination, and integration of regulatory, scientific, and management processes related to LSJR flows.

These goals are used in conjunction with the significance determinations to inform the feasibility of the environmentally superior alternatives relative to the other alternatives. The No Project Alternative does not meet most of the purpose and goals, in part, because it does not allow for flows that more closely mimic the natural hydrographic conditions, it does not provide flows in the geographic area under consideration (it does not allow for flows on the three salmon-bearing tributaries) and it does not allow for adaptive implementation. LSJR Alternatives 2, with adaptive implementation, does not meet purpose and goal 1 and 2 as fully as LSJR Alternatives 3, and 4, with adaptive implementation, since increased flows better advance purpose and goal 1 and 2 related to maintaining inflow conditions from the SJR Watershed sufficient to support and maintain the natural production of viable native fish populations and to providing flows that more closely mimic the natural hydrographic conditions between February through June. LSJR Alternatives 2, 3, and 4 tend to meet purpose and goal 4, 5, 7, and 8 by providing for adaptive implementation, promoting transparency, establishing the STM Working Group and implementing an appropriate monitoring and evaluation program to inform adaptive implementation of LSJR flows and future changes to the Bay-Delta Plan.

There is, however, a difficult tradeoff between providing sufficient inflow to support and maintain the natural production of viable native fish populations migrating through the Delta or flows in a quantity necessary to achieve functions essential to native fishes, as is reflected in goals 1 and 3, and taking into consideration all of the demands being made of the water, as is reflected in goal 6. The degree to which goals 1 and 3 are achieved reduces the amount of water available for other beneficial uses, and vice versa. LSJR Alternative 3, with adaptive implementation, strikes a balance between goals 3 and 6 more fully than the other LSJR alternatives. LSJR Alternative 3 provides flows in a quantity necessary to achieve functions essential to native fishes, such as increased floodplain inundation, improved temperature conditions, improved migratory conditions, and other conditions that favor native fishes over nonnative fishes (Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30,* Tables 19-3 through 19-14 [temperature] and Tables 19-19 through 19-24 [floodplain]). LSJR Alternative 3 also satisfies goal 6 because it takes into consideration the potential costs and economic effects of the flow objective (Chapter 20, *Economic Analyses*). Thus, LSJR Alternative 3, with adaptive implementation, meets more of the purposes and goals of the plan amendments more fully than the other LSJR alternatives.

18.3 SDWQ Alternatives Comparison

18.3.1 Summary of Alternatives Impact Analysis

As stated above in Section 18.2.1, *Summary of Alternatives Impact Analysis*, generally, the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would result in significant impacts on resources requiring or relying on flow in the river(s) or relying on surface water diversions. Specifically, there would be significant impacts on water quality; aquatic biological resources; terrestrial biological resources; agricultural resources; recreational resources, cultural resources, service providers; and energy and greenhouse gases. Thus, the alternative that results in a continuation of, and full compliance with, the existing 2006 Bay-Delta Plan would not avoid environmental impacts.

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, the water quality of the southern Delta under SDWQ Alternatives 2 or 3 would not result in a change to the general range of historical salinity in the southern Delta (0.2 dS/m–1.2 dS/m). This is because the program of implementation included in these alternatives does not call for a change to the USBR compliance requirements at Vernalis (0.7 dS/m from April–August and 1.0 dS/m from September–March as a 30-day average), and the relationship between the salinity at SJR at Vernalis and the southern Delta is not expected to change; thus, a change in baseline is not expected. Therefore, because there is no change to baseline conditions, there are very few impact mechanisms that could result in impacts on resources. As such, Table 18-4 presents a summary of impact determinations related to potential impacts primarily associated with water quality, identified in Chapters 5–15.

SDWQ Alternative 2 would reduce the number of water quality exceedances experienced at the three interior southern Delta compliance stations when compared to baseline. There would be no water quality exceedances at the three interior southern Delta compliance stations under SDWQ Alternative 3 because salinity at these stations has never exceeded 1.4 dS/m. Under SDWQ Alternative 2 or SDWQ Alternative 3, impacts on agricultural resources would be less than significant.

SDWQ Alternative 2 would result in significant impacts on service providers. This is because SDWQ Alternative 2 could result in a change to existing wastewater treatment requirements established by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) in National Pollution Discharge Elimination System (NPDES) permits. The Central Valley Water Board would have to impose effluent limitations consistent with the water quality objective adopted for the southern Delta by the State Water Board in point-source discharge permits for wastewater treatment plants (WWTPs). Therefore, service providers (i.e., City of Tracy and Mountain House Community Services District [CSD]) may not meet the new NPDES effluent limitations that are based on this objective. As such, they may need to modify or construct water treatment facilities or infrastructure, the construction or operation of which could have significant environmental impacts. SDWQ Alternative 3 would not result in significant and unavoidable impacts on service providers because there would be no change from baseline conditions with respect to water quality in the southern Delta. Furthermore, service providers in the southern Delta without existing NPDES permit limitations could likely meet the new effluent limitations if the Central Valley Water Board implements the water quality objective specified in SDWQ Alternative 3.

To comply with either specific salinity water quality objectives or the program of implementation under SDWQ Alternatives 2 or 3, construction and operation of different facilities in the southern Delta could occur, which could involve impacts on different resources (summarized in Table 18-8). While many of these activities would result in no impacts or less-than-significant impacts on different resources, it primarily depends on the location of the activity, the duration of the activity, and the ability of a lead agency to mitigate potentially significant impacts, as to whether activities would result in no impacts or significant and unavoidable impacts, as discussed below, in Section 18.3.2, *Significant and Unavoidable Impacts*.

18.3.2 Significant and Unavoidable Impacts

SDWQ Alternative 2 would result in significant impacts on service providers because SDWQ Alternative 2 could result in a change to existing wastewater treatment requirements established by the Central Valley Water Board in NPDES permits. Therefore, significant and unavoidable impacts could result because service providers may not meet NPDES effluent limitations and may need to construct or operate new WWTP facilities or infrastructure that could cause significant environmental effects on other resources (e.g., aesthetics, terrestrial or aquatic biological resources, cultural resources, etc.).

SDWQ Methods of Compliance

The evaluation contained in Chapter 16, *Evaluation of Other Indirect and Additional Actions,* provides a discussion of the potential methods of compliance associated with SDWQ Alternatives 2 and 3. This chapter does not prescribe different activities under the SDWQ alternatives. Under SDWQ Alternative 2, service providers in the southern Delta (i.e., Cities of Tracy and Stockton and Mountain House CSD) may need to modify current wastewater treatment practices or obtain different source water supplies given their potential to exceed 1.0 dS/m salinity objective (Tables 13-8, 13-9 and 13-19). This could occur through new source water supplies, salinity pretreatment programs or desalination (at wastewater treatment plants). In addition, under the program of implementation for SDWQ Alternative 2, agricultural return flow salinity control in the southern Delta or low lift pumping stations could occur. For SDWQ Alternative 3, modifications to wastewater treatment plants or different source water supply would likely not occur, given the potential ability of the service providers to meet 1.4 dS/m salinity objective (Table 13-20); however, agricultural return flow salinity control or low lift pumping stations could occur under the program of implementation for SDWQ Alternative 3. As such, the combination of different types of methods of compliance that could be taken in response to each of the SDWQ alternatives are unknown; therefore, specific combinations of actions cannot be predictably matched with each alternative.

While agencies could take one or more of these actions, the combination of actions that entities would take under each alternative is speculative and cannot be predictably aligned with each alternative. As such, the summary table below (18-8) focus on the methods of compliance (discussed primarily in Chapter 16) that agencies or entities could undertake under each alternative, without specifically assigning the actions to a particular alternative.

In many cases, the evaluations presented in Chapter 16 include both construction and operation impacts. In cases with both construction and operation, Table 18-8 reflects the highest level of impact, which is frequently related to construction. The determinations are post-mitigation level of significance. Potential mitigation measures are proposed in Chapter 16 to reduce potentially significant impacts (Table 16-38); however, the particular circumstances of the actions and appropriate mitigation measures would be project specific. In addition, as required by CEQA (State CEQA Guidelines § 15126.2) lead agencies would describe a reasonable range of alternatives based on project-specific conditions and project-specific objectives, and one of the alternatives may in and of itself reduce significant environmental impacts. This alternative could be selected as a proposed project. The effectiveness of mitigation is contingent upon several other factors, such as those listed below.

- The ability of lead agencies or other entities to implement the mitigation.
- The other responsible agencies involved in the project.
- The thresholds lead agencies use to evaluate the impact.
- Site-specific conditions.

Lead agencies or other entities with discretionary approval authority can and should impose the relevant mitigation measures identified in Tables 16-38. However, depending on project specifics, implementing mitigation measures may not be fully able to reduce significant impacts, and such impacts may remain significant and unavoidable after mitigation. Until such time that potential mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091. Table 18-8 reflects this.

Table 18-8. CEQA Significance Summary SDWQ Alternatives—Methods of Compliance

Environmental Resource Area	New Source Water Supplies	Salinity Pretreatment Programs	Desalination (WWTP)	Agricultural Return Flow Salinity Control	South Delta Temporary Barriers	Low Lift Pumping Stations
Aesthetics	**SU***	**SU***	**SU***	**L**	**N**	**SU***
Agriculture and Forestry Resources	**SU**	N	**SU***	**SU***	**N**	**SU***
Air Quality	**SU***	**SU***	SU	**L**	**N**	**SU***
Biological Resources	**SU**	**SU***	**SU***	**SU***	**N**	**SU**
Cultural Resources	**SU**	**SU***	**SU***	**SU***	**N**	**SU***
Geology and Soils	**SU***	**SU***	**SU***	**SU***	**N**	**SU***
Greenhouse Gas Emissions	SU	SU	SU	SU	N	SU
Hazards and Hazardous Materials	**SU***	**SU***	**SU***	**SU***	**N**	**SU***
Hydrology and Water Quality	**SU***	**SU***	**SU***	**SU***	**N**	**SU***
Land Use and Planning	**SU***	**SU***	**SU***	**SU***	**N**	**SU***
Mineral Resources	**L**	**L**	**L**	**N**	**N**	**N**
Noise	**SU**	**SU***	**SU**	**SU***	**N**	**SU***
Population and Housing	**L**	**N**	**N**	**N**	**N**	**N**
Public Services	**N**	**N**	**N**	**N**	**N**	**N**
Recreation	**SU***	**SU***	**SU**	**N**	**N**	**N**
Transportation and Traffic	**SU***	**SU***	**SU***	**L**	**N**	**SU***
Utilities and Service Systems	SU	SU	SU	N	**N**	**N**

Environmental Resource Area	New Source Water Supplies	Salinity Pretreatment Programs	Desalination (WWTP)	Agricultural Return Flow Salinity Control	South Delta Temporary Barriers	Low Lift Pumping Stations

Notes:

Bold text indicates primarily construction-driven impacts. Operation-driven impacts are not bold.

* Indicates that the impact after mitigation may be less than significant; however, given the various factors influencing the potential implementation of mitigation, and until such time that mitigation measures are implemented, the impacts would remain significant and unavoidable, consistent with State CEQA Guidelines Section 15091.

SU = significant and unavoidable impact

L = less-than-significant impact

N = no impact

18.3.3 Environmentally Superior Alternative

CEQA requires a discussion of the environmentally superior alternative. If that alternative is the no project alternative, the environmental document shall also identify an environmentally superior alternative among the other alternatives. (Cal. Code Regs., tit. 14, § 15126.6(e).) In considering the selection of the environmentally superior alternative, this SED evaluates which alternatives result in fewer significant impacts relative to the other alternatives, and also considers whether those alternatives are feasible, taking into account economic, environmental, social, technological, and other factors. (Pub. Resources Code, §§ 21081(a)(3), 21061.1.) An agency may conclude that an alternative is infeasible, for example, if it is inconsistent with agency goals or policies or if it will not satisfy project objectives

As discussed above, the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1) would result in significant impacts resulting from changes in flows on the tributaries. Although these changes are not directly related to the implementation of the salinity objective, they are still effects resulting from the No Project Alternative and it is not the environmentally superior alternative.

Under SDWQ Alternative 2, there would be significant and unavoidable impacts on service providers because some service providers (i.e., Cities of Tracy and Stockton and Mountain House CSD) may exceed effluent limitations set at the salinity objective proposed under SDWQ Alternative 2, thus potentially necessitating construction or operation of new, upgraded, or expanded WWTP facilities or infrastructure. Under SDWQ Alternative 3, impacts on service providers would be less than significant because it is expected all service providers may be able to meet effluent limitations if the limitations are set at the salinity objective proposed under SDWQ Alternative 3, with the exception of Deuel Vocational Institution (Deuel). However, currently Deuel is not meeting the effluent limitations, and SDWQ Alternative 3 would not increase the number of existing violations or increase the salinity of the discharge at Deuel. As the Deuel facility comes into compliance with its existing NPDES permit limits, salinity conditions in the southern Delta would correspondingly improve. When considering the environmental impacts of SDWQ Alternatives 2 and 3, SDWQ Alternative 3 would be considered the environmentally superior alternative because it has fewer significant and unavoidable impacts.

Under SDWQ Alternatives 2 and 3, the reasonably foreseeable methods of compliance could result in significant and unavoidable impacts (as disclosed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and Section 18.3.2, *Significant and Unavoidable Impacts*). Fewer methods of compliance (i.e., agricultural return flow and low lift pump stations) may occur under SDWQ Alternative 3, given service providers may not need to modify existing wastewater treatment plants or change source water supplies, when compared to SDWQ Alternative 2. However, significant and unavoidable impacts could still occur under SDWQ Alternative 3 because of the program of implementation and the potential for agricultural return flow salinity control or low lift pumping stations. Since the potential combination of methods of compliance under the SDWQ alternatives is unknown, so is the scope, magnitude and location of the significant and unavoidable impacts. As such, it cannot be concluded that specific significant and unavoidable impacts from the methods of compliance would occur under one SDWQ alternative when compared to another.

The purpose and goals of the salinity objectives and associated program of implementation, as described in Chapter 3, *Alternatives Description,* are as follows.

1. Provide salinity conditions that reasonably protect agricultural beneficial uses of surface waters in the southern Delta.
2. In establishing salinity water quality objectives to reasonably protect agricultural beneficial uses, take into consideration all of the demands being made and to be made on waters in the southern Delta, the LSJR and the three eastside, salmon-bearing tributaries, and the factors to be considered for establishing water quality objectives in Water Code Section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.
3. Establish salinity objectives, supported by existing scientific information, that are not lower than necessary to reasonably protect the most salt sensitive crops currently grown or suitable to be grown on saline- and drainage-impaired soils in the southern Delta.
4. Maintain or improve salinity conditions in the southern Delta to comply with state and federal antidegradation policies.
5. Provide for development and implementation of monitoring and modeling studies needed to better understand the characteristics of salinity conditions in the southern Delta and the dynamics of factors controlling or contributing to those conditions.

These goals are used in conjunction with the significance determinations to inform the feasibility of the environmentally superior alternatives. SDWQ Alternative 3 does not meet purpose and goal 1 and 4 because it requires salinity in the southern Delta at a level that is less protective of agricultural beneficial uses than either SDWQ Alternative 2 or the No Project Alternative. It also does not meet goal 2 because it does not take into consideration the water quality conditions that could reasonably be achieved through the coordinated control of all factors that affect water quality, as required under Water Code Section 13241, because water quality better than the proposed salinity objective could be achieved. The No Project Alternative does not meet goal 3 because the existing salinity objective is lower than necessary to protect the most sensitive crops in the southern Delta. SDWQ Alternative 2 fully meets goals 1 through 5.

Table 18-4. Impact Determinations Identified in Chapters 5–15

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
Chapter 5: Surface Hydrology and Water Quality						
WQ-1: Violate water quality standards by increasing the number of months with EC above the water quality objectives for salinity at Vernalis or southern Delta compliance stations	Less than significant— The No Project Alternative is the continuation of the existing 2006 Bay-Delta Plan, which includes implementation measures to achieve water quality objectives (e.g., the Vernalis and southern Delta EC objectives).Evaluation of monthly flows shows that although a few of the median No Project flows are less than baseline, Vernalis flows are generally higher under the No Project Alternative, especially during years with low flow (which would be more likely to have EC violations). Because higher flows generally reduce EC, the No Project Alternative would not be expected to cause an increase in the amount of time the water quality objectives for salinity are exceeded at Vernalis or southern Delta compliance stations.	Less than significant—There would be an overall reduction in monthly exceedances of EC values for the interior southern Delta compliance stations.	Less than significant—There would be an overall reduction in monthly exceedances of EC values for the interior southern Delta compliance stations.	Less than significant—There would be an overall reduction in monthly exceedances of EC values for the interior southern Delta compliance stations.	Less than significant—There would be an overall reduction of EC values above the new constant 1. 0 dS/m EC objective when compared to existing EC objectives.	Less than significant—There would be a reduction of EC values above the new constant 1.4 dS/m EC objective when compared to existing EC objectives such that there would no longer be any violations.
WQ-2: Substantially degrade water quality by increasing Vernalis or southern Delta salinity (EC) such that agricultural beneficial uses are impaired	Less than significant— See WQ-1.	Less than significant—The range of average EC values during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels is expected to be reduced. Accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	Less than significant—The range of average EC values during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels is expected to be reduced. Accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	Less than significant—The range of average EC values during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels is expected to be reduced. Accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	No impact—This alternative does not have the ability to result in an increase in EC because the baseline 0.7 dS/m Vernalis EC objective would continue to be maintained as part of the program of implementation. Therefore, this alternative would not cause a change in flow or water quality. Accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	No impact—This alternative does not have the ability to result in an increase in EC because the baseline 0.7 dS/m Vernalis EC objective would continue to be maintained as part of the program of implementation. Therefore, this alternative would not cause a change in flow or water quality. Accordingly, it is not anticipated that agricultural beneficial uses would be impaired.
WQ-3: Substantially degrade water quality by increasing pollutant concentrations caused by reduced river flows	Significant—Under the No Project Alternative flows would not be substantially reduced on the Stanislaus, Tuolumne, or LSJR such that contaminant concentrations would increase. However, on the Merced River, flows under the No Project Alternative would be substantially reduced during April and May compared to baseline, which could result in a significant	Less than significant—Flows would generally increase, and no months with low to median flows (10th and 50th percentiles) would experience flow reductions greater than 33% of the baseline flows on the Stanislaus, Tuolumne or Merced Rivers or the LSJR. Therefore, it is expected that the change in concentrations	Less than significant—Flows would generally increase, and no months with low to median flows (10th and 50th percentiles) would experience flow reductions greater than 33% of the baseline flows on the Stanislaus, Tuolumne, or Merced Rivers or the LSJR. Therefore, it is expected that the change in concentrations	Less than significant—Flows would generally increase, and no months with low to median flows (10th and 50th percentiles) would experience flow reductions greater than 33% of the baseline flows on the Stanislaus, Tuolumne or Merced Rivers or the LSJR. Therefore, it is expected that the change in concentrations	No impact – This alternative does not have the ability to result in an increase in pollutant concentrations because the baseline 0.7 dS/m Vernalis EC objective would continue to be maintained as part of the program of implementation. Therefore, this alternative would not cause a change in flow or water quality.	No impact – This alternative does not have the ability to result in an increase in pollutant concentrations because the baseline 0.7 dS/m Vernalis EC objective would continue to be maintained as part of the program of implementation. Therefore, this alternative would not cause in flow or water quality.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	increase in contaminant concentrations above baseline conditions.	would not substantially degrade water quality.	would not substantially degrade water quality.	would not substantially degrade water quality.		
Chapter 6: Flooding, Sediment, and Erosion						
FLO-1: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river in a manner that would result in substantial erosion or siltation on- or off-site	Less than Significant— Under the No Project Alternative, flows would be lower than channel capacities on the Stanislaus, Tuolumne, and Merced Rivers as described under LSJR Alternative 4, in Chapter 6, Flooding, Sediment, and Erosion. Sediment transport, bank erosion or meander-bend migration issues and contribution to levee instability would not increase. It is expected that very occasional gravel transport and bank erosion would occur in the upper gravel-bedded reaches of the Stanislaus, Tuolumne, and Merced Rivers. The amount of bank erosion would be limited by flood action levels and existing bank armoring. Impacts would be less than significant.	Less than significant—Substantial erosion is caused by high flow events resulting from flood control releases of peak flows. These flows would not increase under this alternative. On average, the occurrence of monthly flows greater than 1,500 cfs on the Stanislaus River would be similar to baseline and would not influence stream bank erosion. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in substantial erosion or siltation.	Less than significant—Very occasional gravel transport and bank erosion would occur in the upper gravel-bedded reaches of the three eastside tributaries. The amount of bank erosion is limited by flood stage action levels, which is the river stage at which actions are presumed to occur to reduce flood risk, and existing bank armoring. Flows greater than 1,500 cfs on the Stanislaus River would occur with somewhat greater frequency than baseline, particularly during April to June; however, these flows are not sufficiently high to increase stream bank erosion. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in substantial erosion or siltation.	Less than significant—Similar to LSJR Alternative 3, there would be occasional gravel transport and bank erosion in the upper gravel-bedded reaches of the three eastside tributaries. The amount of bank erosion is limited by the action stage, which is the river stage at which actions are presumed to occur to reduce flood risk, and existing bank armoring. Flows greater than 1,500 cfs on Stanislaus River would occur with greater frequency than baseline, particularly during April to June; however, these flows are not sufficiently high to increase stream bank erosion. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in substantial erosion or siltation.	No impact—Any change in salinity in the southern Delta as a result of southern Delta water quality is expected to be similar to that of the historic range of salinity because Vernalis water quality would be maintained under the SDWQ alternatives through the program of implementation. Furthermore, change in water quality does not affect flooding, sedimentation, or erosion.	No impact—Any change in salinity in the southern Delta as a result of southern Delta water quality (SDWQ) Alternatives 2 or 3 is expected to be similar to that of the historic range of salinity because Vernalis water quality would be maintained under the SDWQ alternatives through the program of implementation. Furthermore, change in water quality does not affect flooding, sedimentation, or erosion.
FLO-2: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in manner that would result in flooding on- or off-site	Less than significant— Flows would be much lower than channel capacities on the Stanislaus, Tuolumne, and Merced Rivers, as described under LSJR Alternative 4, in Chapter 6, Flooding, Sediment, and Erosion. Therefore, significant flooding impacts would not occur outside of floodways. The No Project Alternative would not change reservoir flood storage capacity and would not violate USACE flood reservation, so there would be no changes in flood control releases during major flood events.	Less than significant—Controlled reservoir releases would be much lower than channel capacities and no significant flooding would occur outside of floodway. LSJR Alternative 2 would not change reservoir flood storage capacity and would not violate USACE flood reservation so there would be no changes in flood control operation procedures during major flood events. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in flooding. Consequently, people or structures would not be exposed to a significant risk of loss, injury or death involving flooding.	Less than significant – Similar to LSJR Alternative 2 with respect to flood control operations. Therefore, substantial alterations of the existing drainage patterns would not occur and would not result in flooding. Consequently, people or structures would not be exposed to a significant risk of loss, injury or death involving flooding.	Less than significant—Similar to LSJR Alternative 2, with respect to flood control operations. Substantial alterations of the existing drainage patterns would not occur and would not result in flooding. Consequently, people or structures would not be exposed to a significant risk of loss, injury or death involving flooding.	No impact—See FLO-1.	No impact—See FLO-1.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
Chapter 7: Aquatic Biological Resources						
AQUA-1: Changes in spawning success and habitat availability of warmwater species resulting from changes in reservoir water levels	Significant—Under the No Project Alternative, month-to-month fluctuations in reservoir elevations at New Don Pedro Reservoir would remain similar to the baseline elevations during April-September (the primary spawning, incubation, and early rearing –). Therefore, the availability of warmwater reservoir species habitat and their spawning success would not change at the New Don Pedro Reservoir. However, month-to-month fluctuations at New Melones Reservoir and Lake McClure would be increased under the No Project Alternative during April–September, as compared to baseline. Monthly fluctuations of greater than or equal to 15 feet (ft) would increase by more than 10% during April–August at New Melones Reservoir and during April at Lake McClure. Therefore, warmwater reservoir species habitat would be significantly altered under the No Project Alternative, which would affect the spawning success of these species.	Less than significant—The frequency of 15-foot fluctuations in reservoir levels would not change or would be reduced relative to baseline conditions. Therefore, no significant reductions in spawning success and habitat availability for warmwater species would occur.	Less than significant—The frequency of 15-foot fluctuations in reservoir levels would not change or would be reduced relative to baseline conditions. Therefore, no significant reductions in spawning success and habitat availability for warmwater species would occur	Less than significant—The frequency of 15-foot fluctuations in reservoir levels would not change or would be reduced relative to baseline conditions. Therefore, no significant reductions in spawning success and habitat availability for warmwater species would occur.	No impact – This alternative does not have the ability to result in changes to reservoir salinity because it is not applied at the reservoirs.	No impact – This alternative does not have the ability to result in changes to reservoir salinity because it is not applied at the reservoirs.
AQUA-2: Changes in availability of coldwater species reservoir habitat resulting from changes in reservoir storage	Significant—Under the No Project Alternative, end-of-September storage at New Don Pedro and Lake McClure are expected to remain similar to, or be greater than, the storage under baseline elevations. End-of-September storage is not expected to be significantly reduced when compared to baseline. Therefore, the availability of coldwater reservoir species habitat and their spawning success are not expected to change at these reservoirs. However, on average, end-of-September storage at New Melones Reservoir would be reduced by 27%. Therefore, coldwater reservoir species habitat would be significantly altered under the No Project Alternative, which would affect the spawning success of these species.	Less than significant—Changes in average reservoir storage levels at the end-of-September would range from little or no change to substantial increases relative to baseline levels. Therefore, no significant reductions in coldwater habitat availability would occur.	Less than significant—Changes in average reservoir storage levels at the end-of-September would range from little or no change to substantial increases relative to baseline levels. Therefore, no significant reductions in coldwater habitat availability would occur.	Less than significant—Changes in average reservoir storage levels at the end-of-September would range from little or no change to substantial increases relative to baseline levels. Therefore, no significant reductions in coldwater habitat availability would occur.	No impact – See AQUA-1.	No impact – See AQUA.1.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
AQUA-3: Changes in quantity/ quality of physical habitat for spawning and rearing resulting from changes in flow	Less than significant—Under the No Project Alternative, flows on the Stanislaus River would increase, while flows on the Tuolumne River would be similar to baseline flows and thus would not reduce the quantity and quality of spawning and rearing habitat. Under the No Project Alternative, the Merced River would experience a relatively large percentage reduction in flows in April and May compared to baseline. However, predicted changes in flow within this range correspond to only minor increases or decreases in WUA and no changes in floodplain inundation area. Therefore, they are not likely to substantially affect the amount of physical habitat for Chinook salmon juvenile rearing and steelhead fry rearing.	Less than significant—Suitable spawning habitat on the three eastside tributaries would remain unchanged or increase. Therefore, no significant adverse impacts on the amount of spawning habitat for Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers would occur. No reductions in Chinook salmon fry and juvenile rearing habitat are expected on the Stanislaus River or LSJR compared to baseline. In the Tuolumne and Merced Rivers, weighted usable area (WUA) for Chinook salmon fry and juvenile rearing would decrease, but floodplain habitat would increase in response to higher spring flows. No substantial differences would occur in WUA for steelhead fry and juvenile rearing compared to baseline conditions. No long-term reductions in habitat availability for other native fish species would occur. Therefore, no significant adverse impacts on the amount of habitat for Chinook salmon, steelhead, and other native fishes in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would occur.	Less than significant—Reductions in WUA for Chinook salmon spawning would occur in the three eastside tributaries, but higher flows and lower temperatures are expected to improve attraction and migration and the longitudinal extent of suitable spawning habitat. This alternative would substantially improve rearing habitat conditions for Chinook salmon and steelhead in the three eastside streams and LSJR. Considering the overall beneficial effects of higher flows on rearing habitat availability, no significant adverse impacts on Chinook salmon and steelhead populations would occur. Higher spring flows under this alternative would also benefit other native fish species.	Less than significant—Predicted changes in WUA values for Chinook salmon and steelhead spawning in the Stanislaus, Tuolumne, and Merced Rivers would be similar in magnitude to those predicted under LSJR Alternative 3. This alternative would further improve rearing habitat conditions for Chinook salmon and steelhead in the three eastside tributaries and LSJR. Higher spring flows under this alternative would also further improve habitat conditions for other native fish species. Therefore, no significant adverse impacts would occur.	No impact—this alternative does not have the ability to result in changes to flow because it is a water quality objective for salinity; furthermore, the volume of water needed to meet the Vernalis EC objective is included in the modeling results and, thus, in the impact determinations, for the LSJR alternatives.	No impact – this alternative does not have the ability to result in changes to flow because it is a water quality objective for salinity; furthermore the volume of water needed to meet the Vernalis EC objective is included in the modeling results and, thus, in the impact determinations, for the LSJR alternatives.
AQUA-4: Changes in exposure of fish to suboptimal water temperatures resulting from changes in reservoir storage and releases	Significant—Under the No Project Alternative, temperatures would not increase on the Tuolumne because flows and end-of-September storage would be similar to baseline. However, reductions in April and May flows on the Merced River would very likely increase temperatures in the river in more than half the years (mostly below normal and dry years), in which would increase the frequency of stressful temperatures for Chinook salmon and steelhead rearing and smolt life stages. On the Stanislaus River, higher summer and fall	Less than significant—No substantial changes would occur in exposure of Chinook salmon and steelhead adult migration, spawning and incubation, juvenile rearing, and smolt life stages to suboptimal water temperatures in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Therefore, no significant adverse impacts on Chinook salmon and steelhead populations would occur.	Less than Significant—Decreases in exposure of Chinook salmon and steelhead life stages to suboptimal water temperatures would occur for spawning/incubation in the Tuolumne River (March); spring rearing in the Tuolumne, Merced, and LSJR (April–May); and summer rearing (steelhead only) in the Stanislaus, Tuolumne, and Merced Rivers (July). Therefore, no significant adverse impacts would occur. This alternative would have beneficial temperature effects	Less than significant—Decreases in exposure of Chinook salmon and steelhead life stages to suboptimal water temperatures would occur for spawning/incubation in the Stanislaus, Tuolumne, and Merced Rivers (February–March); spring rearing in the Stanislaus, Tuolumne, Merced, and LSJR (March–May); spring outmigration in the Stanislaus, Tuolumne, and Merced Rivers (April–June); and summer rearing (steelhead only) in the Tuolumne River (July).	No impact— See AQUA-3.	No impact—See AQUA-3.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	release temperatures associated with reduced storage in New Melones Reservoir are also expected to increase the frequency of stressful water temperatures for Chinook salmon and steelhead adult migration, Chinook salmon spawning and incubation, and steelhead rearing life stages, especially in dry years. Flows and water temperatures in the LSJR would remain largely unchanged relative to baseline conditions, which would result in little or no change in exposure of migrating adults and juveniles to stressful water temperatures.		on Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers (including Chinook salmon reared at Merced River Hatchery), and the LSJR.	Therefore, no significant adverse impacts would occur. Overall, this alternative would have beneficial temperature effects on Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers (including Chinook salmon reared at Merced River Hatchery), and the LSJR.		
AQUA-5 : Changes in exposure to pollutants resulting from changes in flow	Significant—Under the No Project Alternative, the exposure to pollutants resulting from changes in flow would not increase on the Stanislaus or Tuolumne Rivers because flows in these rivers would generally be similar to, or greater than, baseline flows. However, on the Merced River, reduction in April and May flows under the No Project Alternative, especially during dry periods, would likely increase pollutant exposure to fish on this river compared to the baseline.	Less than significant—Changes in the frequency and magnitude of flows would not be sufficient to result in long-term changes in dilution effects and exposure of fish to potentially harmful contaminants.	Less than significant—Similar or higher 10th and 50th (median) percentile flows in most months would result in similar or reduced long-term exposure of fish to potentially harmful pollutants. Decreases in exposure of Chinook salmon and steelhead life stages to suboptimal water temperatures would contribute to reductions in the potential for adverse effects associated with contaminant exposure.	Less than significant—Dilution would potentially increase as a result of the increase in flows, and temperatures would either be maintained or reduced; thus, an increase in exposure to pollutants would not occur.	No impact– See AQUA-3.	No impact – See AQUA-3.
AQUA-6: Changes in exposure to suspended sediment and turbidity resulting from changes in flow	Less than significant—Changes in the frequency, duration, and magnitude of increased suspended sediment and turbidity levels would be minor and within the range of historical levels experienced by native fishes and other aquatic species on the three eastside tributaries and the LSJR. Because the No Project Alternative flows during wet years are expected to be less than those described in LSJR Alternative 4 on the Stanislaus River, impacts would be less than those described above. Similar but fewer impacts as those described above would occur on the Tuolumne and Merced Rivers because flows under the No Project Alternative would be similar to or less than baseline flows on these rivers.	Less than significant—Changes in the frequency, duration, and magnitude of increased suspended sediment and turbidity levels are expected to be minor and within the range of historical levels experienced by native fishes and other aquatic species on the three eastside tributaries and the LSJR.	Less than significant—Changes in the frequency, duration, and magnitude of increased suspended sediment and turbidity levels are expected to be minor and within the range of historical levels experienced by native fishes and other aquatic species on the three eastside tributaries and the LSJR.	Less than significant—Changes in the frequency, duration, and magnitude of increased suspended sediment and turbidity levels are expected to be minor and within the range of historical levels experienced by native fishes and other aquatic species on the three eastside tributaries and the LSJR.	No impact—See AQUA-3.	No impact—See AQUA-3

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	Therefore, the change in flows would not mobilize more suspended sediment.					
AQUA-7: Changes in redd dewatering resulting from flow fluctuations	Less than significant—Changes in the frequency and magnitude of flow reductions under the No Project Alternative are not expected in the Stanislaus, Tuolumne, and Merced Rivers when compared to baseline conditions. Therefore, redd dewatering impacts on Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers would be less than significant.	Less than significant— There would be no substantial changes on the major SJR tributaries or the LSJR in the frequency and magnitude of flow reductions associated with potential impacts on Chinook salmon and steelhead redd dewatering.	Less than significant—There would be no substantial changes on the major SJR tributaries or the LSJR in the frequency and magnitude of flow reductions associated with potential impacts on Chinook salmon and steelhead redd dewatering.	Less than significant—There would be no substantial changes on the major SJR tributaries or the LSJR in the frequency and magnitude of flow reductions associated with potential impacts on Chinook salmon and steelhead redd dewatering.	No impact—See AQUA-3.	No impact—See AQUA-3.
AQUA-8: Changes in spawning habitat quality resulting from changes in peak flows	Less than significant—Under the No Project Alternative, substantial changes in the frequency and magnitude of peak flows would not occur relative to LSJR Alternatives 2, 3, and 4 (because the February – June flows at the zero to 10% exceedance level are between those for LSJR Alternatives 2 and 4, Figure 15-2a). Therefore, changes in peak flows would not deleteriously affect the frequency and magnitude of gravel mobilization events in the Stanislaus, Tuolumne, and Merced Rivers, and long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality would not occur.	Less than significant—Modeled results indicate that changes in peak flows are not expected to affect the frequency and magnitude of gravel mobilization events in the Stanislaus, Tuolumne, and Merced Rivers. Therefore, no long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality are expected to occur.	Less than significant—Modeled results indicate that changes in peak flows are not expected to affect the frequency and magnitude of gravel mobilization events in the Stanislaus, Tuolumne, and Merced Rivers. Therefore, no long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality are expected to occur.	Less than significant—Modeled results indicate that changes in peak flows are not expected to affect the frequency and magnitude of gravel mobilization events in the Stanislaus, Tuolumne, and Merced Rivers. Therefore, no long-term changes in geomorphic conditions significantly affecting spawning and rearing habitat quality are expected to occur.	No impact—See AQUA-3.	No impact—See AQUA-3.
AQUA-9: Changes in food availability resulting from changes in flow and floodplain inundation	Less than significant— Under the No Project Alternative, no substantial in frequency and magnitude of floodplain inundation and associated food web conditions would occur on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR (because there would be no substantial decreases in the highest flows). Therefore, no significant impacts on food availability are expected to occur.	Less than significant—No substantial changes are likely to occur in frequency and magnitude of floodplain inundation and associated food web conditions in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Therefore, no significant impacts on food availability are expected to occur.	Less than significant—Higher spring flows and associated increases in riparian and floodplain inundation in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would potentially increase food abundance and growth opportunities for fish on floodplains as well as contribute to downstream food web support. This represents a beneficial effect on aquatic biological resources in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.	Less than significant—Higher spring flows and associated increases in riparian and floodplain inundation in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would potentially increase food abundance and growth opportunities for fish on floodplains as well as contribute to downstream food web support. This represents a beneficial effect on aquatic biological resources in the Stanislaus, Tuolumne, and Merced Rivers and the LSJR.	No impact—See AQUA-3.	No impact—See AQUA-3.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
AQUA-10: Changes in predation risk resulting from changes in flow and water temperature	Significant— Under the No Project Alternative, predation risk would be unlikely to change on the Tuolumne River because flow, storage, and water temperature would be similar to baseline. However, reductions in flow and associated higher temperatures on the Merced River in April and May would very likely increase predation risk for Chinook salmon and steelhead rearing and smolt life stages. On the Stanislaus River, higher summer and fall release temperatures associated with reduced storage in New Melones Reservoir would also increase predation risk for juvenile steelhead, especially in dry years. Flows and water temperatures on the LSJR are expected to remain largely unchanged relative to baseline, which would result in little or no change in predation risk.	Less than significant—No substantial changes are predicted to occur in habitat availability and water temperatures potentially affecting Chinook salmon and steelhead populations or conditions supporting predator populations.	Less than significant—Higher flows and cooler water temperatures in the three eastside tributaries would reduce predation impacts by improving growth opportunities and reducing temperature-related stress in juvenile Chinook salmon and steelhead and limiting the distribution and abundance of largemouth bass and other nonnative species that prey on juvenile salmonids.	Less than significant—Higher flows and cooler water temperatures in the three eastside tributaries would reduce predation impacts by improving growth opportunities and reducing temperature-related stress in juvenile Chinook salmon and steelhead and limiting the distribution and abundance of largemouth bass and other nonnative species that prey on juvenile salmonids.	No impact—See AQUA-3.	No impact—See AQUA-3.
AQUA-11: Changes in disease risk resulting from changes in water temperature	Significant—Under the No Project Alternative, higher summer and fall release temperatures on the Stanislaus River associated with reduced storage in New Melones Reservoir would increase disease risk for Chinook salmon and steelhead adult migration, Chinook salmon spawning and incubation, and steelhead-rearing life stages, especially in dry years. On the Tuolumne River, disease risk would be unlikely to change because flow, storage, and water temperature would be very similar to baseline. However, reductions in flow and associated higher temperatures on the Merced River in April and May would very likely increase disease risk for Chinook salmon and steelhead-rearing and smolt life stages. Flows and water temperatures on the LSJR would remain largely unchanged relative to baseline, which would result in little or no change in disease risk	Less than significant—The frequency of spring water temperatures associated with potential increases in disease risk would stay the same or decrease.	Less than significant—The frequency of spring water temperatures associated with potential increases in disease risk would stay the same or decrease.	Less than significant—The frequency of spring water temperatures associated with potential increases in disease risk would stay the same or decrease.	No impact—See AQUA-3	No impact—See AQUA-3

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
AQUA-12: Changes in southern Delta and estuarine habitat resulting from changes in SJR inflows and export effects	Less than significant—Under the No Project Alternative, Delta operations would continue to be governed by current restrictions on export pumping rates, inflow/export ratios, and Old Middle River (OMR) flows to protect listed fish species from direct and indirect impacts of southern Delta operations. Furthermore, during the primary months of concern for fish using the Delta (December–June), changes in exports would be relatively small and less than the changes under LSJR Alternatives 3 and 4, while average monthly Delta outflow would either be similar to or slightly greater than baseline outflow. Therefore, no significant changes in southern Delta and estuarine habitat are expected to occur under the No Project Alternative.	Less than significant—No substantial changes in southern Delta and estuarine habitat are expected to occur. The combination of monthly changes in pumping rates, SJR flow, and Delta outflow would not have substantial long-term effects on flow patterns in the southern Delta. Furthermore, there would be little effect on Delta outflows and the position of X2; Delta operations would continue to be governed by current restrictions on export pumping rates, inflow/export ratios, and Old Middle River flows to protect listed fish species from direct and indirect impacts of southern Delta operations.	Less than significant—No substantial changes in southern Delta and estuarine habitat are expected to occur. The combination of monthly changes in pumping rates, SJR flow, and Delta outflow would not have substantial long-term effects on flow patterns in the southern Delta. Furthermore, there would be little effect on Delta outflows and the position of X2; Delta operations would continue to be governed by current restrictions on export pumping rates, inflow/export ratios, and Old Middle River flows to protect listed fish species from direct and indirect impacts of southern Delta operations.	Less than significant —No substantial changes in southern Delta and estuarine habitat are expected to occur. The combination of monthly changes in pumping rates, SJR flow, and Delta outflow would not have substantial long-term effects on flow patterns in the southern Delta. Furthermore, there would be little effect on Delta outflows and the position of X2; Delta operations would continue to be governed by current restrictions on export pumping rates, inflow/export ratios, and Old Middle River flows to protect listed fish species from direct and indirect impacts of southern Delta operations.	No impact—See AQUA-3.	No impact—See AQUA-3.
Chapter 8: Terrestrial Biological Resources						
BIO-1 : Have a substantial adverse effect on any riparian habitat or other sensitive natural terrestrial communities identified in local or regional plans, policies, regulations or by CDFW and USFWS	Significant—Fluctuations in reservoir elevations would not be substantially different than those that currently occur. Therefore, the No Project Alternative would not have adverse effects on riparian or other sensitive natural terrestrial communities around the reservoirs. Under the No Project Alternative, flow on the Stanislaus and Tuolumne Rivers and LSJR would not substantially alter riparian habitat or other sensitive natural terrestrial communities because flows on these rivers would be similar to, or greater than, baseline. However, the reduced flow on the Merced River under the No Project Alternative when compared to the baseline would very likely result in a substantial alteration of riparian habitat or other sensitive natural terrestrial communities on this river, especially during moderate to dry years in the spring growing season (April and May).	Less than significant—The change in median monthly flows or overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would not substantially effect riparian habitat or other sensitive terrestrial communities because the plants located within the area of potential effects can survive inundation, are resistant to the effects of scouring and deposition, and are limited by water availability. Fluctuations in reservoir elevations would not be substantially different than those that currently occur. Therefore, the LSJR alternatives would not have significant adverse effects on riparian or wetland habitats or other sensitive terrestrial communities around the reservoirs.	Less than significant—The change in median monthly flows or overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would not substantially effect riparian habitat or other sensitive terrestrial communities because the plants located within the area of potential effects can survive inundation, are resistant to the effects of scouring and deposition, and are limited by water availability. Fluctuations in reservoir elevations would not be substantially different than those that currently occur. Therefore, the LSJR alternatives would not have significant adverse effects on riparian or wetland habitats or other sensitive terrestrial communities around the reservoirs.	Less than significant—The change in median monthly flows or overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would not substantially effect riparian habitat or other sensitive terrestrial communities because the plants located within the area of potential effects can survive inundation, are resistant to the effects of scouring and deposition, and are limited by water availability. Fluctuations in reservoir elevations would not be substantially different than those that currently occur. Therefore, the LSJR alternatives would not have significant adverse effects on riparian or wetland habitats or other sensitive terrestrial communities around the reservoirs.	No impact—No ability to result in changes to flow because it is a water quality objective for salinity; furthermore, the volume of water needed to meet the Vernalis EC objective is included in the modeling results and, thus, in the impact determinations for the LSJR alternatives. Finally, salinity in the southern Delta would remain within the historical range, and the terrestrial plant and animal species can adapt to the variable salinity levels that the southern Delta currently experiences.	No impact—No ability to result in changes to flow because it is a water quality objective for salinity; furthermore, the volume of water needed to meet the Vernalis EC objective is included in the modeling results and, thus, in the impact determinations for the LSJR alternatives. Finally, salinity in the southern Delta would remain within the historical range, and the terrestrial plant and animal species can adapt to the variable salinity levels that the southern Delta currently experiences.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
BIO-2: Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrologic interruption, or other means	Significant— See BIO-1.	Less than significant—Monthly median flows or the cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would generally increase. Increased flow would not adversely affect wetland communities because wetland plants can survive inundation, are resistant to the effects of scouring and deposition, and are growth-limited by water availability. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of this alternative, therefore adverse effects are not expected to occur on wetland communities surrounding the reservoirs. Therefore, substantial adverse effects on wetland communities would not occur.	Less than significant—Monthly median flows or the cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would generally increase. Increased flow would not adversely affect wetland communities because wetland plants can survive inundation, are resistant to the effects of scouring and deposition, and are growth-limited by water availability. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of this alternative, therefore adverse effects are not expected to occur on wetland communities surrounding the reservoirs. Therefore, substantial adverse effects on wetland communities would not occur.	Less than significant—Monthly median flows or the cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR would generally increase. Increased flow would not adversely affect wetland communities because wetland plants can survive inundation, are resistant to the effects of scouring and deposition, and are growth-limited by water availability. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of this alternative, therefore adverse effects are not expected to occur on wetland communities surrounding the reservoirs. Therefore, substantial adverse effects on wetland communities would not occur.	No impact—See BIO-1.	No impact – See BIO-1.
BIO-3: Facilitate an increase in distribution and abundance of invasive plants or nonnative wildlife that would have a substantial adverse effect on native terrestrial species	Less than significant— Invasive plants and animals already exist throughout the watersheds of the Stanislaus, Tuolumne, and Merced Rivers and the LSJR. Although the No Project Alternative could alter vegetation patterns at specific locations, there is no information available to suggest that increased flows on the Stanislaus River or decreased flows on the Merced River would substantially increase the distribution or abundance of invasive plant or nonnative wildlife in a manner that would substantially native terrestrial species.	Less than significant—Changes in flows in the LSJR and the three eastside tributaries and fluctuations in reservoir elevations may result in alteration of vegetation patterns in specific locations, but there is no basis to suggest increased flows would substantially increase the distribution and abundance of invasive plant species. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of this alternative. In addition, the potential for invasive plants and nonnative wildlife species to increase due to a reduction in irrigation water supply availability or potential fallowing would not be expected to exceed existing levels because some agricultural lands would be farmed less intensively,	Less than significant—Changes in flows in the LSJR and the three eastside tributaries and fluctuations in reservoir elevations may result in alteration of vegetation patterns in specific locations, but there is no basis to suggest increased flows would substantially increase the distribution and abundance of invasive plant species. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of this alternative. In addition, the potential for invasive plants and nonnative wildlife species to increase due to a reduction in irrigation water supply availability or potential fallowing would not be expected to exceed existing levels because some agricultural lands would be farmed less intensively,	Less than significant—Changes in flows in the LSJR and the three eastside tributaries and fluctuations in reservoir elevations may result in alteration of vegetation patterns in specific locations, but there is no basis to suggest increased flows would substantially increase the distribution and abundance of invasive plant species. Little change is expected in the frequency and range in water level fluctuation in the reservoirs as a result of this alternative. In addition, the potential for invasive plants and nonnative wildlife species to increase due to a reduction in irrigation water supply availability or potential fallowing would not be expected to exceed existing levels because some agricultural lands would be farmed less intensively,	No impact—See BIO-1.	No impact—See BIO-1.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
		fallowed lands can retain growth, and existing invasive species programs would continue to be implemented. Therefore, an increase in the distribution and abundance of invasive plants or nonnative wildlife is not expected to result from implementation of this alternative.	fallowed lands can retain growth, and existing invasive species programs would continue to be implemented. Therefore, an increase in the distribution and abundance of invasive plants or nonnative wildlife is not expected to result from implementation of this alternative.	fallowed lands can retain growth, and existing invasive species programs would continue to be implemented. Therefore, an increase in the distribution and abundance of invasive plants or nonnative wildlife is not expected to result from implementation of this alternative.		
BIO-4: Have a substantial adverse effect, either directly or through habitat modifications, on any terrestrial animal species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW and USFWS	Significant—Under the No Project Alternative, flows on Stanislaus and Tuolumne Rivers and the LSJR would be similar to, or greater than, baseline. Therefore, the special-status animal species on these rivers would not be substantially affected. However, the reduced flow on the Merced River under the No Project Alternative compared to the baseline would very likely result in substantial effects on special-status species reliant on riparian habitat on this river. Therefore, the special-status animal species on the Merced River would be adversely affected.	Less than significant—Most of the special-status animal species present in the area of potential effects are dependent on riparian habitat. As described above for BIO-1, there would not be a substantial change to available riparian habitat. Similarly, the frequency and range in reservoir elevation fluctuation are not expected to change substantially compared to the baseline conditions consequently, adverse effects are not expected to occur to special-status species or their habitat at the reservoirs. A potential reduction in irrigation water supply in the area of potential indirect effects would not have a substantial adverse effect on special status species due to indirect habitat modification because agricultural land cover would not necessarily be fallowed in perpetuity, as lands could be dryland farmed, deficit irrigated, or rotated. This could result in less agricultural intensive practices on some lands. The resulting halt of mechanized agriculture, pesticide and rodenticide application, and anthropogenic disturbance as a result of less agricultural intensive practices is unlikely to result in a substantial adverse effect on sensitive or special-status	Less than significant—Most of the special-status animal species present in the area of potential effects are dependent on riparian habitat. As described above for BIO-1, there would not be a substantial change to available riparian habitat. Similarly, the frequency and range in reservoir elevation fluctuation are not expected to change substantially compared to the baseline conditions consequently, adverse effects are not expected to occur to special-status species or their habitat at the reservoirs. A potential reduction in irrigation water supply in the area of potential indirect effects would not have a substantial adverse effect on special status species due to indirect habitat modification because agricultural land cover would not necessarily be fallowed in perpetuity, as lands could be dryland farmed, deficit irrigated, or rotated. This could result in less agricultural intensive practices on some lands. The resulting halt of mechanized agriculture, pesticide and rodenticide application, and anthropogenic disturbance as a result of less agricultural intensive practices is unlikely to result in a substantial adverse effect on sensitive or special-status	Less than significant—Most of the special-status animal species present in the area of potential effects are dependent on riparian habitat. As described above for BIO-1, there would not be a substantial change to available riparian habitat. Similarly, the frequency and range in reservoir elevation fluctuation are not expected to change substantially compared to the baseline conditions consequently, adverse effects are not expected to occur to special-status species or their habitat at the reservoirs. A potential reduction in irrigation water supply in the area of potential indirect effects would not have a substantial adverse effect on special status species due to indirect habitat modification because agricultural land cover would not necessarily be fallowed in perpetuity, as lands could be dryland farmed, deficit irrigated, or rotated. This could result in less agricultural intensive practices on some lands. The resulting halt of mechanized agriculture, pesticide and rodenticide application, and anthropogenic disturbance as a result of less agricultural intensive practices is unlikely to result in a substantial adverse effect on sensitive or special-status	No impact—See BIO-1.	No impact—See BIO-1.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
		species. The potential reduction of monocultural irrigated crops is likely to support the species and ecosystem recovery strategy outlined in the USFWS recovery strategy. Therefore, it is not expected that special-status animal species would be adversely affected.	species. The potential reduction of monocultural irrigated crops is likely to support the species and ecosystem recovery strategy outlined in the USFWS recovery strategy. Therefore, it is not expected that special-status animal species would be adversely affected.	species. The potential reduction of monocultural irrigated crops is likely to support the species and ecosystem recovery strategy outlined in the USFWS recovery strategy. Therefore, it is not expected that special-status animal species would be adversely affected.		
BIO-5: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan or conflict with any local policies or ordinances protecting biological resources	Significant—Under the No Project Alternative, flow on Stanislaus and Tuolumne Rivers and the LSJR would not substantially affect riparian habitat or special-status species. Therefore, the No Project Alternative would not conflict with habitat conservation plans or natural community conservation plans for these rivers. However, the reduced flow on the Merced River under the No Project Alternative when compared to baseline conditions could reduce habitat value, which could result in conflicts with habitat conservation plans or natural community plans.	Less than significant—The change in median monthly flows or overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR and changes to the range and/or frequency in reservoir fluctuation would not substantially affect riparian habitat or other sensitive terrestrial communities or the special-status animal species dependent on them (Impact BIO-1and Impact BIO-4). In addition, it is expected that wildlife refuges would continue to receive surface water, as needed, and continue to implement existing water management plans. Therefore, impacts on habitat value would not occur and there would not be a potential to conflict with plans protecting biological resources.	Less than significant—The change in median monthly flows or overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR and changes to the range and/or frequency in reservoir fluctuation would not substantially affect riparian habitat or other sensitive terrestrial communities or the special-status animal species dependent on them (BIO-1and BIO-4). In addition, it is expected that wildlife refuges would continue to receive surface water, as needed, and continue to implement existing water management plans. Therefore, impacts on habitat value would not occur and there would not be a potential to conflict with plans protecting biological resources.	Less than significant—The change in median monthly flows or the overall cumulative distribution of flows on the Stanislaus, Tuolumne, and Merced Rivers and the LSJR and changes to the range and/or frequency in reservoir fluctuation would not substantially affect riparian habitat or other sensitive terrestrial communities or the special-status animal species dependent on them (BIO-1 and BIO-4). In addition, it is expected that wildlife refuges would continue to receive surface water, as needed, and continue to implement existing water management plans. Therefore, impacts on habitat value would not occur and there would not be a potential to conflict with plans protecting biological resources. .	No impact—See BIO-1.	No impact—See BIO-1.
Chapter 9: Groundwater Resources						
Impact GW-1: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge	Less than significant— Surface water diversions on the Tuolumne and Merced Rivers would be similar under the No Project Alternative and baseline. Because there would be no change in surface water availability, the groundwater subbasins (Modesto, Turlock, and Extended Merced) served by these rivers would not be affected by the No Project Alternative. However, surface water diversions on the Stanislaus River would be reduced by approximately 9% under the No Project Alternative; diversions	Less than significant—The average annual groundwater balance is expected to be reduced by less than the equivalent of 1 inch across each of the subbasins. This is not expected to produce a measurable decrease in groundwater elevations. Therefore, there would not be a substantial depletion of groundwater supplies or substantial interference with groundwater recharge.	Significant and unavoidable—The average annual groundwater balance could potentially be reduced by more than the equivalent of 1 inch in three subbasins (Modesto, Turlock, and Extended Merced). If this occurred, it would eventually produce a measurable decrease in groundwater elevations. The effect would be more severe during dry years and in areas farther from the SJR, the valley low point toward which	Significant and unavoidable—The average annual groundwater balance could potentially be reduced by more than the equivalent of 1 inch in all four subbasins (Eastern San Joaquin, Modesto, Turlock, and Extended Merced). If this occurred, it would eventually produce a measurable decrease in groundwater elevations. The effect would be more severe during dry years and in areas farther from the SJR, the valley low point toward which	No impact— This alternative would not result in a change in groundwater pumping or groundwater recharge from surface water that currently takes place in the plan area.	No impact— This alternative would not result in a change in groundwater pumping or groundwater recharge from surface water that currently takes place in the plan area.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	would also be reduced under LSJR Alternatives 2 and 3 (average reduction of 2% and 12%, respectively). As such, the Eastern San Joaquin Subbasin, with is served by the Stanislaus River, would be affected by the reduced surface water diversions. However, the groundwater impacts associated with LSJR Alternative 3 would be less than significant. Because surface water diversions reductions under No Project Alternative (9%) would be less than surface water diversion reductions under LSJR Alternative 3 (12%, the groundwater affects associated with the No Project Alternative would also be less than significant.		groundwater slowly moves. Therefore, there could potentially be a significant and unavoidable depletion of groundwater supplies or substantial interference with groundwater recharge, and resulting potential migration of groundwater contamination under this alternative.	groundwater slowly moves. Therefore, there could be a potentially significant and unavoidable depletion of groundwater supplies or substantial interference with groundwater recharge, and resulting potential migration of groundwater contamination under this alternative.		
Impact GW-2: Cause subsidence as a result of groundwater depletion	Less than significant— As described above for impact GW-1, the effect of the No Project Alternative on groundwater supplies is expected to be less than significant. As a result, subsidence resulting from the No Project Alternative is also expected to be less than significant.	Less than significant— The average annual groundwater balance is expected to be reduced by less than the equivalent of 1 inch across each of the subbasins. This is not expected to produce a measurable decrease in groundwater elevations or associated subsidence.	Significant and unavoidable — The average annual groundwater balance could potentially be reduced by more than the equivalent of 1 inch across three subbasins (Modesto, Turlock, and Extended Merced) under LSJR Alternative 3 and across all four subbasins under LSJR Alternative 4. If this occurred, it could worsen subsidence that is already occurring in the Extended Merced Subbasin. Therefore, there could be a potentially significant and unavoidable increase in subsidence.	Significant and unavoidable — The average annual groundwater balance could potentially be reduced by more than the equivalent of 1 inch across three subbasins (Modesto, Turlock, and Extended Merced) under LSJR Alternative 3 and across all four subbasins under LSJR Alternative 4. If this occurred, it could worsen subsidence that is already occurring in the Extended Merced Subbasin. Therefore, there could be a potentially significant and unavoidable increase in subsidence.	No impact—See GW-1.	No impact—See GW-1.
Chapter 10: Recreational Resources and Aesthetics						
REC-1: Substantially physically deteriorate existing recreation facilities on the rivers or at reservoirs	Significant— During the primary recreation months of May–September, the No Project Alternative could slightly shift recreational activities on the Stanislaus River between May and August to those months that are more suited to higher flows and slightly shift recreational activities on the Merced River during May to those more suited for lower flows. These shifts are unlikely to cause significant recreational impacts.	Less than significant—Modeled flows are not expected to cause substantial physical deterioration of on-bank recreational facilities because the seasonal average frequency of river flows (cubic feet per second [cfs]) would not change substantially from baseline. Modeled flows would also not affect in-water recreational activities because they would not change significantly from	Less than significant— Modeled frequencies of flows greater than 2,500 cfs would change little on the Merced and Stanislaus Rivers, and therefore on-bank recreational facilities would not experience substantially more inundation relative to baseline conditions. However, flows greater than 2,500 cfs would increase in frequency on the Tuolumne River in May and June, but	Significant and unavoidable— There would be a substantial increase in flows above 2,500 cfs on the Tuolumne and Stanislaus Rivers under this alternative. Although on-bank recreational facilities are built to withstand periodic inundation, facilities may substantially physically deteriorate from the expected significant increase in inundation frequency relative	No impact—Changes in salinity would not result in changes to water-dependent or water-enhanced recreation opportunities in the southern Delta. Salinity levels are imperceptible to recreationists who use the southern Delta for water-dependent activities, such as boating or kayaking and water-enhanced activities, such as wildlife viewing.	No impact—Changes in salinity would not result in changes to water-dependent or water-enhanced recreation opportunities in the southern Delta. Salinity levels are imperceptible to recreationists who use the southern Delta for water-dependent activities, such as boating or kayaking, and water-enhanced activities, such as wildlife viewing.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	Under the No Project Alternative, reservoir elevations at New Don Pedro and Lake McClure are expected to remain similar to baseline conditions. Therefore, substantial physical deterioration at existing recreational facilities at these reservoirs is not expected to occur. However, end-of-September reservoir elevations at New Melones would be greatly reduced when compared to baseline, especially during the years with lowest storage. At New Melones Reservoir, boat launches are inoperable when the reservoir elevation is below 850 ft; under the No Project Alternative, the surface of New Melones Reservoir would be below 850 ft approximately 30% of the time in September, which is when recreationists use the reservoir. Therefore, it is anticipated that the No Project Alternative would interfere with the operation of boat ramps and this could result in a substantial physically deterioration of facilities at New Melones Reservoir, and thus reduce the use of existing recreation facilities.	baseline. Under this alternative, there would be relatively small changes in reservoir elevations. These changes would not substantially deteriorate existing recreational facilities at the reservoirs because all boat ramps and other facilities would remain available to recreationists.	would remain close to baseline values July – September. Although the flows on the Tuolumne River could likely result in an increase in the frequency of inundation of on-bank recreation areas during May and June, recreational facilities are not anticipated to substantially physically deteriorate along the river. On-bank recreational facilities are built to withstand periodic inundation with higher river flows. The modeled seasonal average frequency of low flows (less than 500 cfs) on the Merced and Tuolumne Rivers would decrease more than 10% relative to baseline conditions. However, during July-September, the most popular recreational months for the three eastside tributaries, the frequency of low flows would change by less than 10% relative to baseline for the three eastside tributaries. Therefore, this alternative is not anticipated to affect in-water activities. The change in reservoir elevations under this alternative would not significantly affect recreation at New Melones or Lake McClure. It is expected that there would be a substantial decrease in elevation at New Don Pedro Reservoir. However, because all boat ramps would remain operable at the 30% cumulative distribution elevation (e.g., dry years), and some boat ramps in New Don Pedro Reservoir are still operable at minimum reservoir elevations, there would be no physical deterioration nor reduction in the use of existing recreation	to baseline. The modeled seasonal average frequency of low flows on the Merced and Tuolumne Rivers, without adaptive implementation, would decrease more than 10%. The decrease is mostly due to low flow reduction in May and June. However, because there would be little change in low flows on the Stanislaus, Merced, and Tuolumne Rivers relative to baseline during the warmest months in the San Joaquin Valley when swimming and wading are most popular (July–August), the reduced opportunity for swimming and wading on the three eastside tributaries in May, and particularly in June (i.e., early in the summer recreational season), is not expected to substantially reduce recreational use for the season. Seasonal average elevations at Lake McClure and New Melones Reservoir are expected to increase. The seasonal average elevation at New Don Pedro Reservoir is expected to decrease at the 30% cumulative distribution elevation. Decreased reservoir levels at New Don Pedro Reservoir would not substantially physically deteriorate existing recreation facilities at the reservoirs (marinas and boat ramps), and all boat ramps would remain operable. There would be no reduction in use of the facilities at New Don Pedro Reservoir. Therefore, given the significant increase in the modeled frequency of high seasonal average flows (greater than 2,500 cfs) on the Tuolumne and Stanislaus Rivers associated with LSJR Alternative 4,		

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
			facilities at this location.	substantial physical deterioration of existing recreational facilities is expected.		
REC-2: Substantially degrade the existing visual character or quality of the reservoirs	Significant— Under the No Project Alternative, reservoir elevations at New Don Pedro and Lake McClure would remain relatively constant and would not be substantially reduced compared to baseline. Therefore, substantial degradation of the visual character and quality of area surrounding these reservoirs would not occur. However, summer elevations at New Melones Reservoir would be reduced when compared to baseline, especially during years with lowest storage. At the 30% cumulative distribution level, the May–September seasonal average No Project Alternative elevation would be reduced by more than 50 ft, well above the 10-foot level identified as the criteria for significance. This reduction would substantially degrade the existing visual character or quality of the New Melones Reservoir.	Less than significant—Under certain conditions, reservoir elevations at Lake McClure and New Melones Reservoir could increase and could result in an improvement to the existing views. The decrease in reservoir elevation that could occur at New Don Pedro Reservoir would not result in a substantial degradation of existing visual character or quality.	Less than significant—Under certain conditions, reservoir elevations would increase at Lake McClure and New Melones Reservoir and could improve the existing views. At New Don Pedro Reservoir, decreases in water surface elevation during some dry years could cause a substantial degradation of existing visual character or quality; however, views at this location are Class III, and changes to the character of the landscape can be moderate without compromising visual quality.	Less than significant—Under certain conditions, reservoir elevations would increase at Lake McClure and New Melones Reservoir and could improve the existing views. At New Don Pedro Reservoir, decreases in water surface elevation during some dry years could cause a substantial degradation of existing visual character or quality; however, views at this location are Class III, and changes to the character of the landscape can be moderate without compromising visual quality.	No impact— This alternative would not apply directly to the reservoirs, and the USBR Vernalis salinity requirement in the program of implementation for this alternatives is the same as under baseline conditions.	No impact—This alternative would not apply directly to the reservoirs, and the USBR Vernalis salinity requirement in the program of implementation for this alternatives is the same as under baseline conditions
Chapter 11: Agricultural Resources						
AG-1: Potentially convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural uses	Significant— Under the No Project Alternative, in areas that receive surface water from the Tuolumne and Merced Rivers, a conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to non-agricultural uses would not be expected because surface water diversions on the Tuolumne and Merced Rivers would not be significantly reduced. Therefore, it is anticipated that a substantial reduction in crop acreage would not occur in these watersheds and a conversation of these types of farmland to nonagricultural uses would not occur. The No Project Alternative would result in conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance	Less than significant—Potential reductions in surface water diversions could result in a less than 4% average reduction in irrigated acreage for the irrigation districts in the LSJR area of potential effects.	Significant and unavoidable—Approximately 22,879 acres, on average, of Prime or Unique farmland or Farmland of Statewide Importance requiring irrigation, could have reduced surface water diversions, and it is reasonable to assume that a portion could potentially be converted to nonagricultural uses even though land can be maintained in agricultural use through crop substitution, crop rotation, and dry land farming. Specifically, reductions in surface water diversions could result in reduced acres of irrigated land for Alfalfa for SSJID, MID, and TID; Grain in MID; Field Crops in SSJID, MID and TID; Pasture in SSJID, OID, MID, and TID; Rice in SSJID and	Significant and unavoidable—Approximately 70,640 acres on average of Prime or Unique Farmland or Farmland of Statewide Importance requiring irrigation could have reduced surface water diversions, and it is reasonable to assume that a portion could potentially be converted to nonagricultural uses even though land could be maintained in agricultural use through the crop substitution, crop rotation, and dry land farming. Specifically, reductions in surface water diversions could result in reduced acres of irrigated land for Alfalfa, Pasture, Corn, Grain, and Field in SSJID, OID, MID, and Merced ID; Rice and Safflower in SSJID, OID, and MID; Dry Bean and	Less than significant—No reduction or conversion of agricultural acreage is likely because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.	Less than significant—No reduction or conversion of agricultural acreage is likely because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	to nonagricultural uses as a result of the reductions in surface water diversions on the Stanislaus River. The average reduction in surface water diversions of 9% would be slightly greater than the reduction under LSJR Alternative 2 with adaptive implementation (average reduction of % with implementation of adaptive implementation method 1[30% unimpaired flow]) and slightly less than the reduction described for LSJR Alternative 3 (average reduction of 12% at 40% unimpaired flow requirement). LSJR Alternative 3 would result in significant impacts on agricultural resources of the irrigation districts that receive water from the Stanislaus River. Although reductions in surface water supply under the No Project Alternative would be slightly less than those expected for LSJR Alternative 3, significant impacts would occur.		MID; and Dry Beans and Processing Tomatoes in SSJID. Those potential average reductions in irrigated acreage range from 0.8% for Merced ID to 9.9% for MID.	Cucurbits in SSJID, OID, MID, and Merced ID; Processing and Fresh Tomato and Truck in SSJID, and Truck in SSJID, MID, and TID. Those potential average reductions in irrigated acreage range from 2.6% for Merced ID to 27.5% for MID.		
AG-2: Involve other changes in the existing environment which, due to their location or nature, could result in a conversion of farmland to nonagricultural use	Less than significant—Flows on the Stanislaus River would be increased, which may result in seepage; however, given the small amount of acreage for crops that could be affected, impacts would be less than significant. Similar to conditions under the LSJR alternatives, given the cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distributions from local water suppliers, it is unlikely that dairies, as an agricultural use, would be converted to nonagricultural uses. Impacts would be less than significant.	Less than significant—Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.01% of irrigated acreage; therefore, crop production would not be substantially reduced.	Less than significant—Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced. Given cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies, as an agricultural use, would be converted to nonagricultural uses.	Less than significant—Impacts on irrigated agriculture from a high water table resulting from increased river flows on the Stanislaus River are expected on less than 0.1% of irrigated acreage; therefore, crop production would not be substantially reduced. Given cost of feed input compared to other dairy inputs and the availability of the feed input, the value of dairy production in the LSJR area of potential effects, and the potential use of equitable distribution of local water suppliers, it is unlikely dairies, as an agricultural use, would be converted to nonagricultural uses.	Less than significant – Conversion of farmland to nonagricultural use is not expected because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.	Less than significant – Conversion of farmland to nonagricultural use is not expected because water quality within the southern Delta is expected to remain unchanged as USBR would be responsible for complying with the same salinity requirements that currently exist at Vernalis.
AG-3: Conflict with existing zoning for agricultural use or a Williamson Act contract	Less than significant—The No Project Alternative would not conflict with existing zoning for agricultural use or Williamson Act contracts because the No Project Alternative would not change zoning. Lands that are under	Less than significant—This alternative would not conflict with existing zoning for agricultural use or Williamson Act contracts because it would not change zoning, and lands that are under Williamson Act	Less than significant—This alternative would not conflict with existing zoning for agricultural use or Williamson Act contracts because it would not change zoning, and lands that are under Williamson Act	Less than significant—This alternative would not conflict with existing zoning for agricultural use or Williamson Act contracts because it would not change zoning, and lands that are under Williamson Act	Less than significant—This alternative would not conflict with existing zoning for agricultural use or Williamson Act contracts because it would not change zoning, and agricultural lands would	Less than significant—This alternative would not conflict with existing zoning for agricultural use or Williamson Act contracts because it would not change zoning, and agricultural lands would

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	Williamson Act contracts must be maintained in the compatible uses specified in those contracts until non-renewed, canceled, or otherwise withdrawn from contract. Lands that experience a reduction in surface water supply could be dry farmed, rotated, or fallowed, all of which would be agricultural activities that are consistent with agricultural zoning and Williamson Act contracts.	contracts must be maintained in the compatible uses specified on those contracts until non-renewed, canceled, or otherwise withdrawn from contract. Lands that experience a reduction in surface water supply could be dryfarmed, rotated, or fallowed, all of which would be agricultural activities that are consistent with agricultural zoning and Williamson Act contracts.	contracts must be maintained in the compatible uses specified on those contracts until non-renewed, canceled, or otherwise withdrawn from contract. Lands that experience a reduction in surface water supply could be dryfarmed, rotated, or fallowed, all of which would be agricultural activities that are consistent with agricultural zoning and Williamson Act contracts.	contracts must be maintained in the compatible uses specified on those contracts until non-renewed, canceled, or otherwise withdrawn from contract. Lands that experience a reduction in surface water supply could be dryfarmed, rotated, or fallowed, all of which would be agricultural activities that are consistent with agricultural zoning and Williamson Act contracts.	continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.	continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.
AG-4: Conflict with any applicable land use plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect	Less than significant— The No Project Alternative would not conflict with applicable land use plans, policies, or regulations because while some agricultural land could be taken out of irrigated agricultural use as a result of the No Project Alternative, many of these lands could actually remain in agricultural use, even if they are not irrigated. Furthermore, local agencies have accommodated the conversion and preservation or protection of agricultural lands through various means including: agricultural mitigation programs, agricultural preservation easements, or general plan policies that protect and preserve agricultural land.	Less than significant— This alternative would not conflict with applicable land use plans, policies, or regulations because it is not proposing amendments to existing land use plans, policies, or regulations. While some agricultural land could be taken out of irrigated agricultural use as a result of this alternative, many of these lands could remain in agricultural use, even if they are not irrigated and must remain in uses that are compatible with applicable local land use plans, policies or regulations.	Less than significant— This alternative would not conflict with applicable land use plans, policies, or regulations because it is not proposing amendments to existing land use plans, policies, or regulations. While some agricultural land could be taken out of irrigated agricultural use as a result of this alternative, many of these lands could remain in agricultural use, even if they are not irrigated and must remain in uses that are compatible with applicable local land use plans, policies or regulations.	Less than significant— This alternative would not conflict with applicable land use plans, policies, or regulations because it is not proposing amendments to existing land use plans, policies, or regulations. While some agricultural land could be taken out of irrigated agricultural use as a result of this alternative, many of these lands could remain in agricultural use, even if they are not irrigated and must remain in uses that are compatible with applicable local land use plans, policies or regulations.	No impact— This alternative would not conflict with applicable land use plans, policies, or regulations because it would not change zoning, and agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.	No impact— This alternative would not conflict with applicable land use plans, policies, or regulations because it would not change zoning, and agricultural lands would continue to divert water from existing waterways and rely on suitable water quality to irrigate crops.
Chapter 12: Cultural Resources						
CUL-1: Cause a substantial adverse change in the significance of a historical or archaeological resource	Significant—Changes in river flows are not expected to alter the low potential for significant cultural resources to exist along rivers due to previous natural and anthropogenic disturbances. Given the low potential, impacts would be less than significant on the three eastside tributaries and the LSJR. Reservoir elevations at New Don Pedro and Lake McClure are expected to remain relatively constant when compared to baseline. Therefore, substantial adverse changes in the significance of historical or archeological resources are not expected at these	Less than significant—The expected changes in reservoir elevations are within historical fluctuations, and known or unknown significant cultural resources are expected to continue to be inundated or exposed as usual under current operations. Additionally, historic property management plans at the reservoirs would continue to be implemented. Changes in river flows are not expected to alter the low potential for significant cultural resources to exist along rivers due to previous natural and	Less than significant—The expected changes in reservoir elevations are within historical fluctuations, and known or unknown significant cultural resources are expected to continue to be inundated or exposed as usual under current operations. Additionally, historic property management plans at the reservoirs would continue to be implemented. Changes in river flows are not expected to alter the low potential for significant cultural resources to exist along rivers due to previous natural and	Less than significant—The expected changes in reservoir elevations are within historical fluctuations, and known or unknown significant cultural resources are expected to continue to be inundated or exposed as usual under current operations. Additionally, historic property management plans at the reservoirs would continue to be implemented. Changes in river flows are not expected to alter the low potential for significant cultural resources to exist along rivers due to previous natural and	No impact – The historic range of salinity because Vernalis water quality would be maintained through the program of implementation. Since the chemical properties of the baseline water quality conditions would not change, there would be no potential to substantially adversely impact significant cultural resources.	No impact—The historic range of salinity because Vernalis water quality would be maintained through the program of implementation. Since the chemical properties of the baseline water quality conditions would not change, there would be no potential to substantially adversely impact significant cultural resources.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	reservoirs. However, the end-of-September storage at New Melones Reservoir is anticipated to be greatly reduced in over half the years when compared to baseline, and this would most likely expose cultural resources, and could result in a substantial adverse change to the significance of existing cultural resources if they were disturbed by people or disturbed by another physical method (e.g., light, exposure).	anthropogenic disturbances.	anthropogenic disturbances.	anthropogenic disturbances.		
CUL-2: Disturb any human remains, including those interred outside formal cemeteries	Less than significant—The potential for human remains to exist within the fluctuation zone of the reservoirs is low. As a result, the changes in New Melones Reservoir elevations under the No Project Alternative are unlikely to result in disturbance of human remains. In addition, considering the prior disturbance by agriculture, irrigation practices, mining activities, and development within the riverine floodplains, the change in flows under the No Project Alternative would have an extremely low potential to disturb documented or currently undocumented human remains, including those interred outside formal cemeteries.	Less than significant—The expected changes in reservoir elevations are within historical fluctuations and are not expected to affect human remains due to low potential for human remains to exist within the fluctuation zone of the reservoirs Additionally, existing management plans at the reservoirs would continue to be implemented. Additionally, any human remains would be treated in accordance with existing state and federal regulations. Changes in river flows are not expected to alter the low potential for undocumented human remains to exist along rivers due to previous natural and anthropogenic disturbances.	Less than significant—The expected changes in reservoir elevations are within historical fluctuations and are not expected to affect human remains due to low potential for human remains to exist within the fluctuation zone of the reservoirs Additionally, existing management plans at the reservoirs would continue to be implemented. Additionally, any human remains would be treated in accordance with existing state and federal regulations. Changes in river flows are not expected to alter the low potential for undocumented human remains to exist along rivers due to previous natural and anthropogenic disturbances.	Less than significant—The expected changes in reservoir elevations are within historical fluctuations and are not expected to affect human remains due to low potential for human remains to exist within the fluctuation zone of the reservoirs Additionally, existing management plans at the reservoirs would continue to be implemented. Additionally, any human remains would be treated in accordance with existing state and federal regulations. Changes in river flows are not expected to alter the low potential for undocumented human remains to exist along rivers due to previous natural and anthropogenic disturbances.	No impact – See CUL-1.	No impact – See CUL-1.
CUL-3: Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature	Significant—The potential for paleontological resources within and adjacent to the LSJR and the Stanislaus, Tuolumne, and Merced Rivers is considered low due to the depth of occurrence of rock units with high paleontological potential below reworked surficial sediments and Holocene-age floodplain and channel deposits. Buried paleontological resources would be found at soil and rock depth too deep for the rivers to modify or change. Reservoir elevations at New Don Pedro and Lake McClure are expected to remain relatively	Less than significant—The expected changes in reservoir elevations are within historical fluctuations, and unique paleontological or geologic resources, specifically caves, are expected to continue to be inundated and exposed as they currently are under operations. Additionally, the documented caves are managed and protected under a cave management plan. Changes in river flows are not expected to alter the low potential for paleontological resources to	Less than significant—The expected changes in reservoir elevations are within historical fluctuations, and unique paleontological or geologic resources, specifically caves, are expected to continue to be inundated and exposed as they currently are under operations. Additionally, the documented caves are managed and protected under a cave management plan. Changes in river flows are not expected to alter the low potential for paleontological	Less than significant—The expected changes in reservoir elevations are within historical fluctuations, and unique paleontological or geologic resources, specifically caves, are expected to continue to be inundated and exposed as they currently are under operations. Additionally, the documented caves are managed and protected under a cave management plan. Changes in river flows are not expected to alter the low potential for paleontological	No impact – See CUL-1.	No impact – See CUL-1.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	constant or generally greater, not significantly reduced, when compared to baseline. Therefore, disturbance of unique paleontological resources is not expected at these reservoirs. However, the-end-of September storage at New Melones is anticipated to be greatly reduced in over half the years when compared to baseline, and this could lead to the disturbance of paleontological resources, such as caves.	exist along rivers due to depth of occurrence of rock units with high paleontological potential.	resources to exist along rivers due to depth of occurrence of rock units with high paleontological potential.	resources to exist along rivers due to depth of occurrence of rock units with high paleontological potential.		
Chapter 13: Service Providers						
SP-1: Require or result in the construction of new water supply facilities or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects	Significant— Under existing conditions, existing wastewater treatment plant dischargers (i.e., Cities of Tracy, Stockton, and Manteca, and Mountain House CSD) are required to comply with National Pollution Discharge Elimination System (NPDES) permit requirements and waste discharge requirements. However, the southern Delta salinity water quality objectives do not currently apply to the City of Tracy and other municipal dischargers. If the southern Delta salinity objectives are not applied to the municipal dischargers, then the No Project Alternative would not result in a change to the NPDES permit or other discharger requirements; the No Project Alternative would not result in the need to expand existing facilities or infrastructure and would not result in significant environmental effects. However, it is reasonable to expect that the litigation in City of Tracy v. California State Water Resources Control Board will be resolved in the foreseeable future in a manner that will allow for the application of the Delta salinity objectives to municipal wastewater dischargers. The increase in flow expected under the No Project Alternative would reduce the salinity in the southern Delta at the interior compliance stations and achieve compliance at	Less than significant—Average surface water diversions on the Stanislaus, Tuolumne, and Merced Rivers would be reduced by 2%, 2%, and 6%, respectively, compared to baseline conditions. Further, there would not be a substantial depletion of groundwater supplies; therefore, it is not expected that service providers or public water suppliers would need to construct or operate new water supply or wastewater treatment facilities or expand existing facilities.	Significant and unavoidable—Surface water diversion reductions on the Stanislaus, Tuolumne, and Merced Rivers are expected to be approximately 12%, 14% and 16%, respectively. Further, as a result of the substantial reduction of surface water supply on the rivers, it is expected that there would be a substantial depletion of groundwater supplies in the Modesto, Turlock, and Extended Merced Subbasins. These reductions would potentially require service providers to construct new or expanded water supply or wastewater treatment facilities, the construction of which could result in significant environmental effects.	Significant and unavoidable—Surface water diversion reductions on the Stanislaus, Tuolumne, and Merced Rivers are expected to be approximately 32%, 35%, and 32%, respectively. Further, as a result of the substantial reduction of surface water supply on the rivers, it is expected that there would be a substantial depletion of groundwater supplies in the Eastern San Joaquin, Modesto, Turlock, and Extended Merced Subbasins. These reductions would potentially require service providers to construct new or expanded water supply or wastewater treatment facilities, the construction of which could result in significant environmental effects.	Significant and unavoidable—The Cities of Tracy, Stockton and Mountain House CSD may need to construct new wastewater treatment facilities or expand existing facilities to comply with potential changes to NPDES effluent limitation implementing a 1.0 dS/m salinity objective, the construction of which could result in significant environmental effects.	Less than significant—The construction of new wastewater treatment facilities is not expected in order to comply with changes to NPDES effluent limitations implementing a 1.4 dS/m objective for salinity. As such, construction would not occur and would not result in significant environmental effects.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	these stations. However, based on current effluent discharge concentrations and past violations, it is unlikely that existing service providers would be able to meet the current 2006 Bay-Delta Plan salinity objective of 0.7 dS/m from April to August. Additionally, it is unlikely that the Cities of Tracy and Stockton meet the current 2006 Bay-Delta Plan salinity objective of 1.0 dS/m from September–March. Therefore, it is expected that these service providers would exceed wastewater treatment requirements during some parts of the year and that the construction of new wastewater treatment facilities, or the expansion of existing facilities or infrastructure, could result; construction or operation of the facilities could cause significant environmental effects.					
SP-2a: Violate any water quality standards such that drinking water quality from public water systems would be affected	Less than significant— The No Project Alternative is unlikely to reduce surface drinking water quality because flows at Vernalis would be higher than baseline. In addition, a higher flow at Vernalis is generally associated with better water quality. A reduction in the quality of groundwater drinking supply is not expected because the effect of the No Project Alternative on groundwater supplies is expected to be less than significant (as shown in Impact GW-1 has under the No Project Alternative).	Less than significant—Because service providers and irrigation districts relying primarily on surface water would not need to supplement their supply with groundwater under LSJR Alternative 2, there would likely be no degradation of groundwater quality. During some months, salinity in the SJR at Vernalis and in the southern Delta channels may increase slightly, but on average, salinity is expected to be reduced; therefore, a substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur, and impacts would be less than significant	Less than significant—As a result of increased groundwater pumping, reductions in groundwater levels in the Modesto, Turlock, and Extended Merced Subbasins under LSJR Alternative 3 could affect groundwater quality. However, a substantial increase in groundwater pumping would not necessarily result in an increase in violation of water quality standards for drinking water because recent data do not indicate increased water quality standard violations in public water systems despite greatly increased groundwater pumping, and if a drinking water quality problem is detected, action would be taken (as covered under SP-1) to improve water quality. Salinity in the SJR at Vernalis and in the southern Delta channels is expected to be reduced; therefore, a substantial degradation of	Less than significant—As a result of increased groundwater pumping, reductions in groundwater levels in the Modesto, Turlock, Merced and Easter San Joaquin Subbasins. However, a substantial increase in groundwater pumping would not necessarily result in an increase in violation of water quality standards for drinking water because recent data do not indicate increased water quality standard violations in public water systems despite greatly increased groundwater pumping, and if a drinking water quality problem is detected, action would be taken (as covered under SP-1) to improve water quality. Salinity in the SJR at Vernalis and in the southern Delta channels is expected to be reduced; therefore, a substantial degradation of water quality affecting service providers diverting drinking	Less than significant—The USBR water rights permits will continue to include requirements to meet the current 0.7 EC April–August Vernalis salinity standard, as contained in the program of implementation. This would maintain the historical range of salinity in the southern Delta. Therefore, a substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur.	Less than significant—The USBR water rights permits will continue to include requirements to meet the current 0.7 EC April–August Vernalis salinity standard, as contained in the program of implementation. This would maintain the historical range of salinity in the southern Delta. Therefore, a substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
			water quality affecting service providers diverting drinking water from the southern Delta would not occur. Therefore, impacts would be less than significant.	water from the southern Delta would not occur. Therefore, impacts would be less than significant.		
SP-2b: Violate any water quality standards such that drinking water quality from domestic wells would be affected.c	Less than significant- See SP-2a.	Less than significant—Because service providers and irrigation districts relying primarily on surface water would not need to supplement their supply with groundwater under LSJR Alternative 2, there would likely be no degradation of groundwater quality.	Significant and unavoidable—As a result of increased groundwater pumping, reductions in groundwater levels in the Modesto, Turlock, and Extended Merced Subbasins could affect groundwater quality. Domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. There is no required mechanism to prevent private domestic wells from using groundwater that may exceed MCLs. Therefore, impacts would be significant.	Significant and unavoidable—As a result of increased groundwater pumping, reductions in groundwater levels in the Modesto, Turlock, Merced and Easter San Joaquin Subbasins could affect groundwater quality. Domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. There is no required mechanism to prevent private domestic wells from using groundwater that may exceed MCLs. Therefore, impacts would be significant.	No impact—Salinity in the SJR at Vernalis and in the southern Delta is not relevant to groundwater and drinking water quality from domestic wells and, therefore, there would be no impact from the changes in salinity in these surface waters.	No impact—Salinity in the SJR at Vernalis and in the southern Delta is not relevant to groundwater and drinking water quality from domestic wells and, therefore, there would be no impact from the changes in salinity in these surface waters.
SP-3: Result in substantial changes to SJR inflows to the Delta such that insufficient water supplies would be available to service providers relying on CVP/SWP exports	Less than significant—Under the No Project Alternative, average annual inflows to the Delta at Vernalis would increase slightly relative to baseline as a result of the No Project Alternative, and average annual exports could increase slightly, by 26 TAF/y. Consequently, service providers relying on CVP/SWP exports would not be adversely affected.	Less than significant—Inflows would generally remain similar to baseline and, as such, a reduction in average annual exports to the CVP and SWP export service areas is not expected. Therefore, insufficient water supplies to service providers relying on exports would not occur and would not require or result in the construction of new water supply facilities or wastewater treatment facilities or the expansion of existing facilities.	Less than significant—Inflows would generally increase relative to baseline, which would result in an estimated average increase in exports of 76 TAF/y to the CVP and SWP export service areas. Therefore, insufficient water supplies to service providers relying on exports would not occur and would not require or result in the construction of new water supply facilities or wastewater treatment facilities or the expansion of existing facilities.	Less than significant—Inflows would generally increase relative to baseline, which would result in an estimated average increase in exports of 194 TAF/y to the CVP and SWP export service areas. Therefore, insufficient water supplies to service providers relying on exports would not occur and would not require or result in the construction of new water supply facilities or wastewater treatment facilities or the expansion of existing facilities.	No impact – The flows to satisfy the USBR Vernalis EC requirement contained in the program of implementation are already included in the modeling results for the LSJR alternatives.	No impact – The flows to satisfy the USBR Vernalis EC requirement contained in the program of implementation are already included in the modeling results for the LSJR alternatives.
Chapter 14: Energy and Greenhouse Gases						
EG-1: Adversely affect the reliability of California's electric grid	Less than significant—Under the No Project Alternative, a moderate reduction in the capacity of New Melones hydroelectric plant in July and August during dry years could result in minor reliability violations. However, the New Melones hydroelectric plant is located in a SMUD region. The report of SMUD's	Less than significant—Transmission line loadings would not exceed the limits under contingency outage conditions because hydropower generation and reservoir elevation would not be substantially modified. Therefore, adverse effects on	Less than significant—Transmission line loadings would not exceed the limits under contingency outage conditions because hydropower generation and reservoir elevation would not be substantially modified. Therefore, adverse effects on	Less than significant—Transmission line loadings would not exceed the limits under contingency outage conditions after re-dispatch of generator facilities to correct a minor violation between Borden and Gregg substations and Gregg and Storey	No impact—The general historical range of salinity in the southern Delta would remain unchanged under and, thus, would not adversely affect the reliability of California's electric grid.	No impact— The general historical range of salinity in the southern Delta would remain unchanged and, thus, would not adversely affect the reliability of California's electric grid.

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	2013 Ten-year Transmission Assessment Plan indicates that there are adequate generating resources in the SMUD region to meet its load demand and planning reserve margin obligations until 2018. So it is likely that the minor violations could be alleviated by re-dispatching electrical power from other generating resources available either in a local region or neighboring regions. Therefore, the No Project Alternative would not adversely affect the reliability of California's electric grid and the impact of the reduction in the New Melones capacity would be less than significant.	the reliability of California's electric grid would not occur.	the reliability of California's electric grid would not occur.	substations. Re-dispatches are regular occurrences in the California energy grid, and they provide a solution to redistribute power. Therefore, adverse effects on the reliability of California's electric grid would not occur.		
EG-2: Result in inefficient, wasteful, and unnecessary energy consumption	Less than significant— The No Project Alternative could result in additional energy consumption as a result of groundwater pumping. However, because groundwater pumping may be necessary to maintain the water supply irrigation demand, the No Project Alternative would not result in inefficient, wasteful, and unnecessary consumption of energy. Furthermore, it is anticipated that if new groundwater wells were to be installed, they would be efficient. The No Project Alternative could result in additional energy generation at other facilities to compensate for a potential loss of hydropower. However, this increased electricity generation is not considered inefficient, wasteful, and unnecessary as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower.	Less than significant—Additional groundwater pumping would not result in inefficient, wasteful, and unnecessary consumption of energy to the extent groundwater pumping is used to meet water supply irrigation demand in accordance with state law. Additional energy generation at other facilities to compensate for a potential loss of hydropower would not be considered inefficient, wasteful, and unnecessary as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. Therefore, there would be no inefficient, wasteful or unnecessary energy consumption.	Less than significant—Additional groundwater pumping would not result in inefficient, wasteful, and unnecessary consumption of energy to the extent groundwater pumping is used to meet water supply irrigation demand in accordance with state law. Additional energy generation at other facilities to compensate for a potential loss of hydropower would not be considered inefficient, wasteful, and unnecessary as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. Therefore, there would be no inefficient, wasteful or unnecessary energy consumption.	Less than significant—Additional groundwater pumping would not result in inefficient, wasteful, and unnecessary consumption of energy to the extent groundwater pumping is used to meet water supply irrigation demand in accordance with state law. Additional energy generation at other facilities to compensate for a potential loss of hydropower would not be considered inefficient, wasteful, and unnecessary as it is energy that would be generated to maintain the energy supply level that is currently supplied by hydropower. Therefore, there would be no inefficient, wasteful or unnecessary energy consumption.	No impact—The general historical range of salinity in the southern Delta would remain unchanged under and, thus, would not result in inefficient, wasteful, and unnecessary energy consumption.	No impact—The general historical range of salinity in the southern Delta would remain unchanged under and, thus, would not result in inefficient, wasteful, and unnecessary energy consumption.
EG-3: Generate GHG emissions, either directly or indirectly, that have a significant impact on the environment	Significant—The No Project Alternative could result in an increase in groundwater pumping and a potential shift from hydropower to non-hydropower energy production as a result of the expected reduction in surface water diversions and change to flow on the Stanislaus River. Both of these	Less than significant—Emissions would not exceed the 10,000 MTCO2e threshold. Therefore, GHG emissions would not have a significant impact on the environment.	Significant and unavoidable—Emissions exceed the 10,000 MT CO2e threshold. Therefore, GHG emissions would have a significant impact on the environment.	Significant and unavoidable—Emissions exceed the 10,000 MT CO2e threshold. Therefore, GHG emissions would have a significant impact on the environment.	NA—The general historical range of salinity in the southern Delta would remain unchanged under and, thus, would not result in direct GHG emissions. Significant indirect GHG emissions may be produced through the construction and operation of facilities in the southern Delta	NA—The general historical range of salinity in the southern Delta would remain unchanged under and, thus, would not result in direct GHG emissions. Significant indirect GHG emissions may be produced through the construction and operation of

Impact	No Project Alternative (LSJR/SDWQ Alternative 1)	LSJR Alternative 2a	LSJR Alternative 3 a	LSJR Alternative 4 a	SDWQ Alternative 2	SDWQ Alternative 3
	would be expected to generate GHG emissions greater than the threshold of 10,000 MT of GHGs, as described for both LSJR Alternative 3 and 4.				(Table 18-8) that could exceed GHG thresholds depending on the nature of the activity.	facilities in the southern Delta (Table 18-8) that could exceed GHG thresholds depending on the nature of the activity.
EG-4: Conflict with an applicable plan, policy, or regulation adopted for the purposes of reducing the GHG emissions	Significant—Since the No Project Alternative would exceed the 10,000 MT GHG threshold, it would conflict with existing applicable plans, policies, or regulations adopted for the purposes of reducing GHG emissions, such as AB32, the California Global Warming Solutions Act.	Less than significant—Since GHG emissions would not exceed the 10,000 MT CO2e threshold, there would be no conflict with applicable plans, policies or regulations adopted for the purpose of reducing GHGs.	Significant and unavoidable— – Since GHG emissions would exceed the 10,000 MT CO2e threshold, there would be a conflict with applicable plans, policies or regulations adopted for the purpose of reducing GHGs.	Significant and unavoidable—Since GHG emissions would exceed the 10,000 MT CO2e threshold, there would be a conflict with applicable plans, policies or regulations adopted for the purpose of reducing GHGs.	No impact – The general historical range of salinity in the southern Delta would remain unchanged and, thus, would not result in GHG emissions or conflict with an applicable plan, policy or regulation adopted for the purpose of reducing GHG emissions.	No impact – The general historical range of salinity in the southern Delta would remain unchanged and, thus, would not result in GHG emissions or conflict with an applicable plan, policy or regulation adopted for the purpose of reducing GHG emissions.
EG-5: Effect of global climate change on the LSJR and SDWQ alternatives	Less than significant—The State Water Board is required to prepare WQCPs. The WCQPs are regularly reviewed to update water quality standards. As a result, the planning process continually accounts for changing conditions related to water quality and water planning, such as climate change. Therefore, the effect of global climate change on the No Project Alternative would be less than significant.	Less than significant—Climate change would not significantly affect LSJR Alternative 2 because adaptive implementation would allow agencies to respond to changing circumstances with respect to flow and water quality that might arise due to climate change. Furthermore, the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning such as climate change.	Less than significant—Climate change would not significantly affect LSJR Alternative 3 because adaptive implementation would allow agencies to respond to changing circumstances with respect to flow and water quality that might arise due to climate change. Furthermore, the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning such as climate change.	Less than significant—Climate change would not significantly affect LSJR Alternative 4 because adaptive implementation would allow agencies to respond to changing circumstances with respect to flow and water quality that might arise due to climate change. Furthermore, the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning such as climate change.	Less than significant—Climate change would not significantly affect SDWQ Alternative 2 because the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning, such as climate change.	Less than significant – Climate change would not significantly affect SDWQ Alternative 3 because the required review and update of WQCPs, accounted for in the program of implementation, continually accounts for changing conditions related to water quality and water planning, such as climate change.

NA = not applicable
EC = electrical conductivity (salinity)
dS/m = deciSiemens per meter
CDFW = California Department of Fish and Wildlife
USFWS = U.S. Fish and Wildlife Service
NPDES = National Pollution Discharge Elimination System

USACE = U.S. Army Corps of Engineers
USBR = U.S. Bureau of Reclamation
SSJID = South San Joaquin Irrigation District
MID = Modesto Irrigation District
TID = Turlock Irrigation District
OID = Oakdale Irrigation District
Merced ID = Merced Irrigation District
CVP = Central Valley Project
SWP = State Water Project

GHG = greenhouse gas
CO2e = carbon dioxide equivalent
MT = megatons
AB32 = Assembly Bill 32, California Global Warming Solutions Act
WQCP = Water Quality Control Plans

[a] Impact determinations are without adaptive implementation included. For a summary of what determinations changed with and without adaptive implementation, refer to Table 18-5.

Chapter 19
Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30

19.1 General Introduction

The State Water Resources Control Board (State Water Board) is in the process of reviewing the San Joaquin River (SJR) flow objectives for the protection of fish and wildlife beneficial uses, water quality objectives for the protection of southern delta agricultural beneficial uses, and the program of implementation for those objectives contained in the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (2006 Bay-Delta Plan). The project area, which includes the Stanislaus, Tuolumne, and Merced Rivers and the Lower SJR (LSJR) between the confluence of the Merced River and Vernalis, is the focus of the following benefits analysis.

This chapter presents biologically important and measurable benefits of providing higher and more variable flow during the February 1 through June 30 time period. Specifically, the benefits of improved temperature and floodplain habitat relative to Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*) during February through June are quantified and compared between Baseline flows, and 20%, 30%, 40%, 50%, and 60% unimpaired flows[1] on the lower Stanislaus, Tuolumne, Merced, and LSJ Rivers. However, modifying flows in this time period may have unanticipated temperature benefits or impacts during other time periods. For example, modifying flow requirements in the spring season could alter reservoir levels in the fall and result in changes to river temperatures. Therefore, potential temperature effects were analyzed during all months of the year on these rivers. By evaluating the full range of unimpaired flows (20-60%), and evaluating effects during all months of the year, this chapter includes the range of unimpaired flows that could occur under the LSJR alternatives described in Chapter 3, *Alternatives Description*, because adaptive implementation could be applied to each of the alternatives.

In addition to evaluating temperature and floodplain benefits of the project, a life-history population simulation model for fall-run Chinook salmon originating from the SJR and its upper three east-side salmon bearing tributaries (Stanislaus, Tuolumne, and Merced Rivers) was used to provide insight into population level changes that could be expected under a variety of unimpaired flow scenarios. The model used is called SalSim and was developed by the California Department of Fish and Wildlife (CDFW), AD Consultants, and a variety of other modeling and fisheries experts (CDFW 2013a; CDFW 2014). The State Water Board used the model to compare effects of unimpaired and baseline flow scenarios on salmon by evaluating potential changes in annual salmon production.

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[1] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

The results of the temperature, floodplain, and SalSim analysis presented in this chapter indicate that as the percentage of unimpaired flow is increased during the February through June time period, the flow related benefits to salmon and steelhead also increase. Improving flows that mimic the natural hydrographic conditions including related temperature and floodplain regimes to which native fish species are adapted, are expected to provide many juvenile salmonids with additional space, time, and food resources which are necessary for required growth, development, and survival. Extending spatial, temporal, and nutritional opportunities available to juvenile fall-run Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers is expected to improve abundance, productivity, diversity, and spatial structure of the SJR Basin and Central Valley populations, and should also provide substantial benefits to other native fish in the SJR Watershed. Improving and maintaining these important population attributes should help buffer SJR Basin and Central Valley fall-run Chinook salmon populations from catastrophic events and conditions in the future.

Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, documents the scientific basis and technical resources that were used in the recirculated substitute environmental document (SED) to analyze project effects in accordance with CEQA requirements. The purpose of this chapter is to supplement the information contained in Appendix C by quantitatively evaluating the benefits of this project in terms of potentially available cold water and floodplain habitats, and associated population implications to native salmonids.

The information contained in this chapter is intended to assist the State Water Board in its water quality control planning process and decision making as part of that process. The water quality control planning process has requirements separate and apart from CEQA and the information contained in this chapter is not a requirement of CEQA. One of the purposes of CEQA is to inform governmental decision makers and the public about the potential, significant environmental effects of proposed activities (State CEQA Guidelines, § 15002(a)(1)). Significant effects on the environment are defined as a substantial adverse change in physical conditions which exist in the area affected by the proposed project (i.e., significant impacts) (State CEQA Guidelines, § 15002(g)). To satisfy CEQA requirements, impacts on various resources are evaluated and significance determinations are made in Chapters 5 through 16 and Appendix B, *State Water Board's Environmental Checklist*, of this SED.

19.1.1 Problem Statement

Scientific evidence indicates that reductions in flows and alterations to the flow regime in the SJR Basin, resulting from water development over the past several decades, have negatively impacted fish and wildlife beneficial uses. As outlined in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, water development in the SJR Basin has resulted in: reduced annual flows, fewer peak flows, reduced and shifted spring and early summer flows, reduced frequency of peak flows from winter rainfall events, shifted fall and winter flows, and a general decline in hydrologic variability over multiple spatial and temporal scales. Currently, there is relatively little unregulated runoff from the SJR Basin with dams regulating at least 90% of the inflow (Cain et al. 2010). Dams and diversions in the SJR Basin have caused a substantial overall reduction of flows, compared to unimpaired hydrographic conditions, with a median reduction in annual flows at Vernalis of 54% and median reduction of spring flows of 74%, 83%, and 81% during April, May, and June, respectively.

The SJR Basin once supported large spring-run and fall-run (and possibly late fall-run) Chinook salmon populations; however, the basin now only supports fall-run Chinook salmon populations, and these populations are facing a high risk of extinction (see Mesick 2009, 2010a, 2010b). The Stanislaus, Tuolumne, and Merced Rivers (individually or combined) have had larger reductions in the natural production of adult fall-run Chinook salmon than any of the other tributaries (or combination of three tributaries) to the Sacramento or San Joaquin Rivers when comparing the 1967-1991 and 1992-2011 time periods (Figure 19-1).

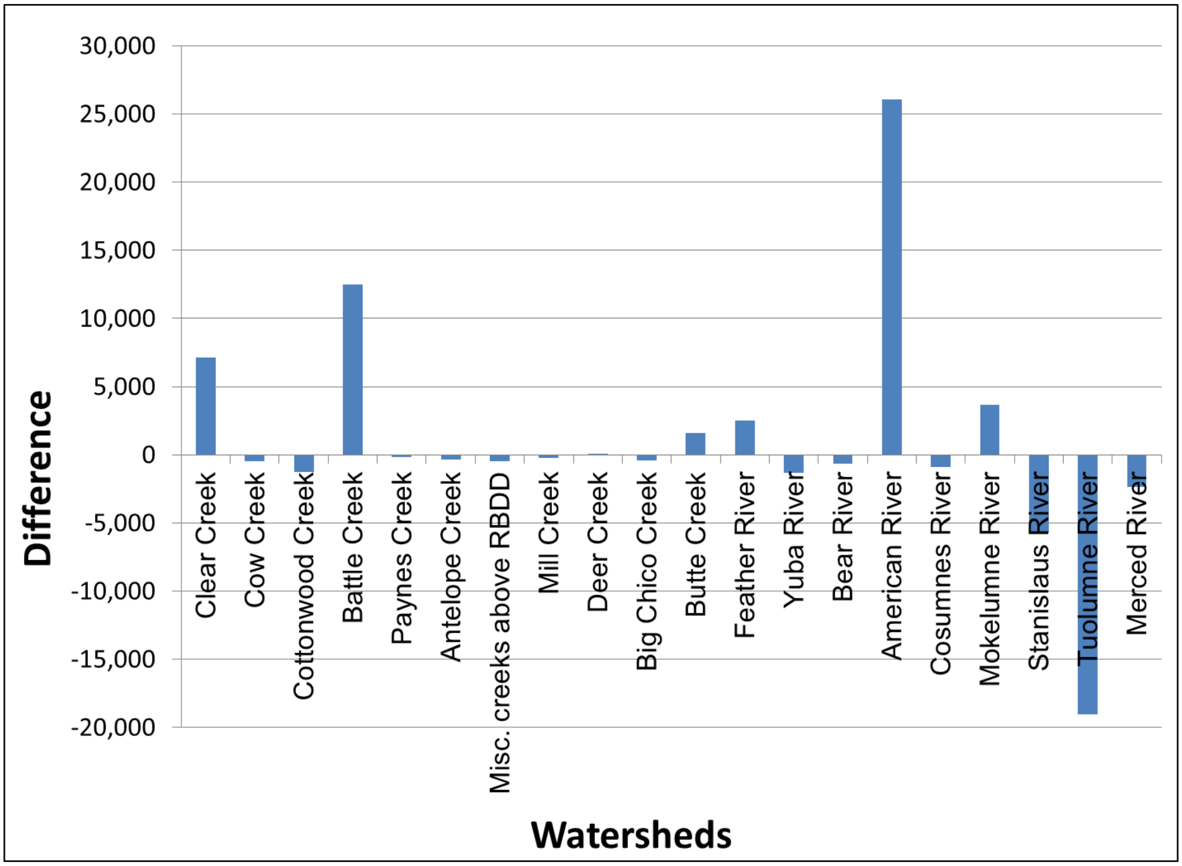

Figure 19-1. Difference in natural production of adult fall-run Chinook salmon when comparing the 1967-1991 average and the 1992-2011 average in tributaries to the Sacramento or San Joaquin Rivers, showing that salmon declines in the tributaries to the San Joaquin River are greater compared to other watersheds in recent decades. Difference = (1992-2011 time period average of estimated yearly natural production as reported in USFWS 2013a) minus (1967-1991 time period average of estimated yearly natural production as reported in USFWS 2013a) (repeated for each watershed).

Flows in the SJR Basin affect various life stages of fall-run Chinook salmon, including adult migration, adult spawning, egg incubation, juvenile rearing, and outmigration to the Pacific Ocean. Analyses of historical abundance indicate that late winter and spring flows (February through June) in the tributaries and mainstem SJR have had a strong influence on survival and abundance of SJR Basin salmon since records began in the 1940s or 1950s (Figure 19-2; and CDFG 2005a; Mesick and Marston 2007; Mesick et al. 2007; Mesick 2009; Sturrock et al. 2015).

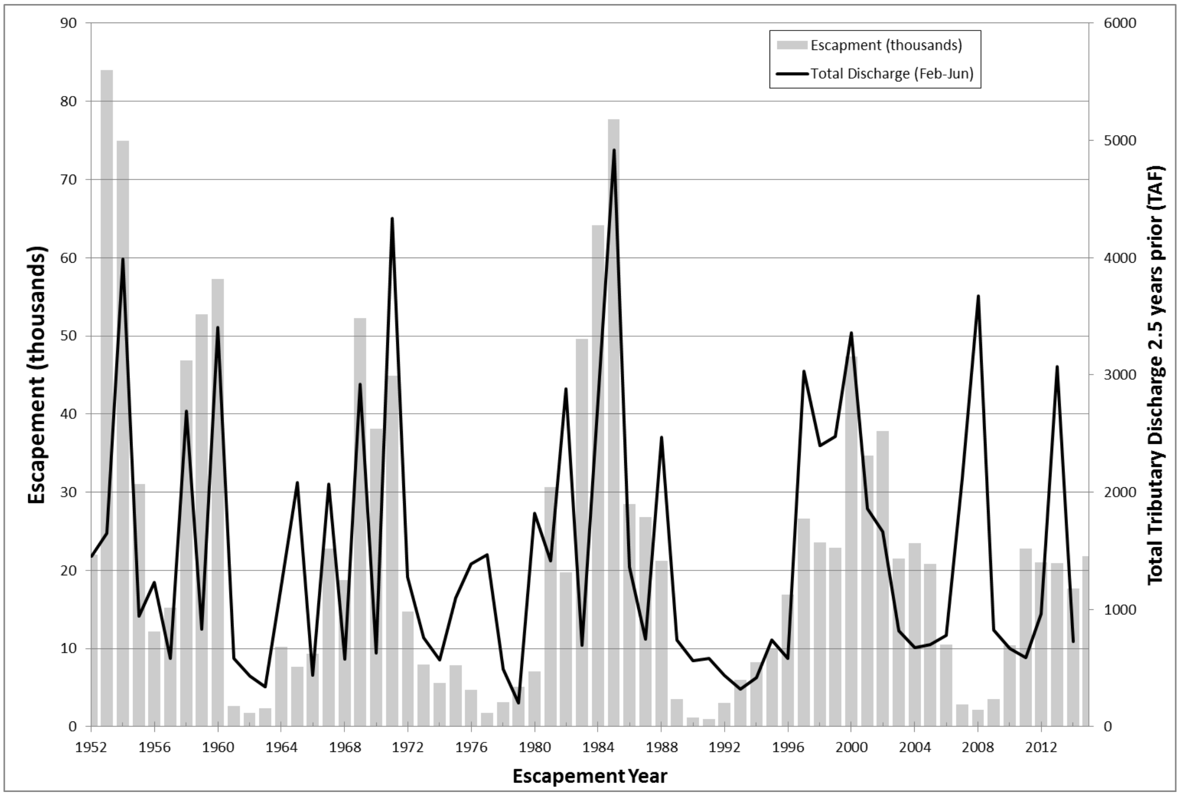

Figure 19-2. Relationship between adult salmon returns to the San Joaquin basin and the river flows they experienced as juveniles. Fall-run Chinook salmon returns (escapement) to the Stanislaus, Tuolumne, and Merced rivers combined from 1952-2014 relative to the total discharge (Thousand Acre-Feet) during the February through June outmigration period they experienced 2.5 years prior as juveniles. Salmon data from CDFW GrandTab 2014.04.22 and GrandTab 2016.04.11. Flow data for the Stanislaus, Tuolumne, and Merced Rivers combined from USGS gages 11303000, 11290000, and 11270900 respectively. Note that adult abundance estimates have not been corrected for age distributions (we assumed that all adults returned at age 3), or for out-of-basin straying. The large deviation in 2007 reflects poor returns that were attributed to poor ocean conditions (Lindley 2009) and resulted in the closure of the fishery. Adapted from Sturrock et al. 2015.

Therefore, while SJR Basin flows at other times are also important, the focus of the State Water Board's current review is on flows within the salmon-bearing tributaries and the mainstem SJR at Vernalis (inflows to the Delta) during the critical salmon rearing and outmigration period of February through June. Scientific evidence indicates that in order to protect fish and wildlife beneficial uses in the SJR Basin, including increasing the populations of SJR Basin fall-run Chinook salmon and Central Valley steelhead to sustainable levels, changes to the current flow regime of the SJR Basin are needed. Specifically, a more natural flow regime from the salmon bearing tributaries (Stanislaus, Tuolumne, and Merced Rivers) is needed during the February through June time frame (see Appendix C *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*,).

19.1.2 Importance of a Natural Flow Regime

There are many important benefits to maintaining a natural flow regime, some of which are described in the following summary by Kiernan et al. (2012, page 1472):

> The flow regime of a stream is often regarded as the ''master variable'' that determines composition of biotic assemblages (Poff and Ward 1989, Power et al. 1995, Matthews 1998). Many environmental factors that affect assemblage structure, including temperature, water chemistry, and physical habitat complexity, are determined by flow to a certain extent (Bunn and Arthington 2002). For streams in Mediterranean climates, such as northern California, USA, annual patterns of precipitation produce a hydrograph characterized by episodic high-discharge events during winter and by protracted periods of low flow throughout summer and early fall. Although the magnitude and frequency of hydrologic disturbance events such as extreme floods and extended low flows are highly variable from year to year, the timing (seasonality) of these events is largely predictable (Gasith and Resh 1999, Power et al. 2008). Thus, many native freshwater and riparian species have evolved traits and life-history strategies to withstand natural hydrologic variability and to rapidly recover from disturbance (Bonada et al. 2007, Power et al. 2008, Yarnell et al. 2010). Conversely, alien (nonnative) species often lack biological and behavioral mechanisms to cope with region-specific flow regimes and are often disproportionately vulnerable (e.g., via physical displacement, recruitment failure, or direct mortality) to high and low stream flow conditions.

As described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, natural flow regimes have been dramatically altered in the Bay-Delta plan area. The Stanislaus, Tuolumne, and Merced Rivers have significantly lower and flatter winter and spring hydrographs, and significantly higher summer and fall hydrographs. See Figure 19-3 as an example of an altered hydrograph during a wet year, and see Figure 19-4 as an example of an altered hydrograph during a critically dry year.

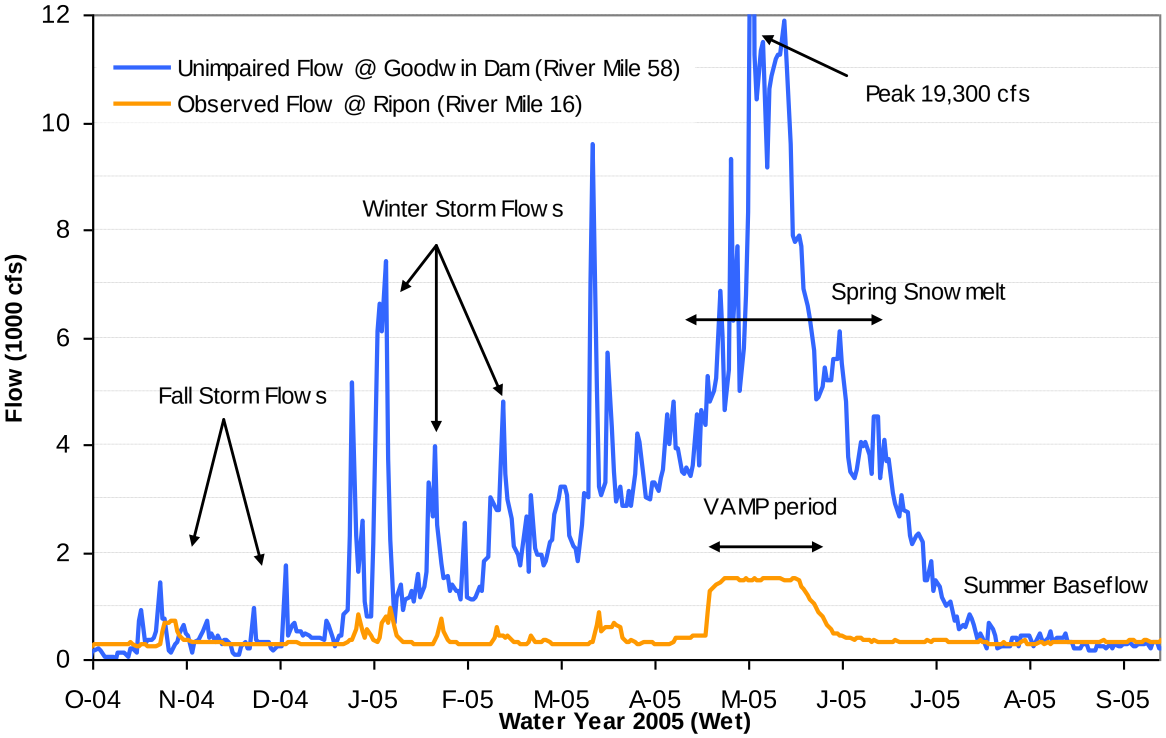

Figure 19-3. Typical Stanislaus River annual hydrograph of daily average unimpaired and observed flows during a wet water year (2005) illustrating important hydrograph components.

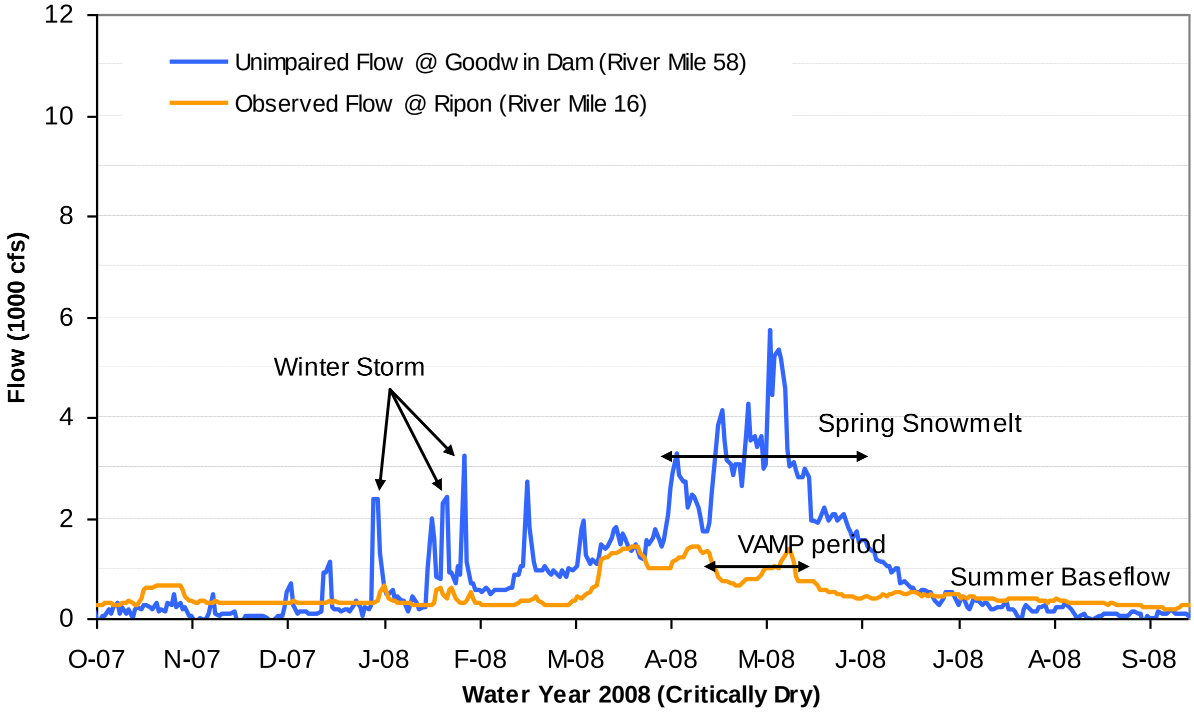

Figure 19-4. Typical Stanislaus River annual hydrograph of daily average unimpaired and observed flows during a critically dry water year (2008) illustrating important hydrograph components.

CalFED (2008) suggested that altering the hydrographs of Central Valley rivers has had significant ecological consequences—including changes in the establishment, distribution, composition, and survival of naturally recruited riparian vegetation; and changes in the timing and distribution of migration, spawning, and rearing of green sturgeon, Chinook salmon, and steelhead.

Seasonally-correct variable flow conditions provide the environment needed to support biological and ecosystem processes which are imperative to the protection of native fish and wildlife beneficial uses. Although changes to ecosystem attributes, in addition to flows, are needed to fully restore biological and ecosystem processes in the Bay-Delta plan area, flow remains a critical element of that restoration.

Using a river's unaltered hydrographic conditions as a foundation for determining ecosystem flow requirements is well supported by scientific literature (Poff et al. 1997; Tennant 1976; Orth and Maughan 1981; Marchetti and Moyle 2001; Mazvimavi et al. 2007; Moyle et al. 2011). In addition, major regulatory programs in Texas, Florida, Australia and South Africa have developed flow prescriptions based on unimpaired hydrographic conditions in order to enhance or protect aquatic ecosystems (Arthington et al. 1992; Arthington et al. 2004; NRDC 2005; Florida Administrative Code 2010), and the World Bank now uses a framework for ecosystem flows based on the unaltered quality, quantity, and timing of water flows (Hirji and Davis 2009). Many researchers involved in developing ecologically protective flow prescriptions concur that mimicking the unimpaired hydrographic conditions of a river is essential to protecting populations of native aquatic species and promoting natural ecological functions (Sparks 1995; Walker et al. 1995; Richter et al. 1996; Poff et al. 1997; Tharme and King 1998; Bunn and Arthington 2002; Richter et al. 2003; Tharme

2003; Poff et al. 2006; Poff et al. 2007; Brown and Bauer 2009). Poff et al. (1997) describe that the flow regime limits the distribution and abundance of riverine species (Resh et al. 1988; Power et al. 1995) and regulates the ecological integrity of rivers. The structure and function of riverine ecosystems, and the adaptations of their constituent freshwater and riparian species, are determined by patterns of intra- and inter-annual variation in river flows (Poff et al. 1997; Naiman et al. 2008, Mount et al. 2012). A key foundation of the natural flow paradigm is that the long-term physical characteristics of flow variability have strong ecological consequences at local to regional scales, and at time intervals ranging from days (ecological effects) to millennia (evolutionary effects) (Lytle and Poff 2004). Nearly every other habitat factor that affects community structure, from temperature, to water chemistry to physical habitat complexity, is determined by flow to a certain extent (Bunn and Arthington 2002).

In a recent analysis of methods used for establishing environmental flows for the Bay-Delta, Fleenor et al. (2010) reported on two methods for determining flows needed to protect the ecosystem: 1) flows based on the unimpaired flow, and 2) flows based on the historical flow. These methods attempt to prescribe flows for the protection of the ecosystem as a whole, and use the biological concept that more variable inflows to the Sacramento-San Joaquin Delta (Delta), which mimic unaltered hydrographic conditions to which native aquatic species have adapted, will benefit native aquatic species. In a separate review of instream flow science by Petts (2009), he reports the importance of two fundamental principles that should guide the derivation of flow needs: 1) flow regime shapes the evolution of the aquatic biota and ecological process; and 2) every river has a characteristic flow regime and associated biotic community. Petts (2009) also finds that flow management should sustain flows that mimic the yearly, seasonal, and perhaps daily variability to which aquatic biota have adapted.

The current updates to the Bay-Delta Plan include improving flow conditions during the February through June time period so that they more closely mimic the natural hydrographic conditions to which native fish species are adapted, including the relative magnitude, duration, timing, and spatial extent of flows as they would naturally occur. This document describes the benefits of the project to native salmon and steelhead in terms of improvements to temperature and floodplain habitat in response to the proposed changes in flow conditions which will more closely mimic the natural hydrographic conditions during February through June.

19.2 Temperature

Dams and reservoirs, and their associated operations, alter the temperature regime of rivers, often to the detriment of native species such as salmonids and other animals, and plants, that are adapted to the natural flow regime of their native rivers (Richter and Thomas 2007; CDFG 2010b). Typically, water stored in reservoirs is warmer at the surface and cooler below the thermocline in deeper waters. The temperature of water within these layers is generally different than the temperature of water entering the reservoir at any given time depending on the season, and is also dissimilar to downstream water temperatures that would occur under a natural flow regime (USACE 1987; Bartholow 2001). In addition to altering downstream temperature regimes, dams also physically block access to cooler high elevation habitats historically available to native migratory fish species.

Currently, temperature management on the major SJR tributaries can only be achieved directly through flow management (NMFS 2009c). While temperature control devices can control the temperature of water released from dams for the protection of downstream fisheries by varying operations of release gates for example, there are currently no temperature control devices to aid in water temperature management on the major SJR tributary dams.

Often, water released from reservoirs is colder in the summer and warmer in the winter compared to water temperatures that would have occurred in the absence of a dam and reservoir (see Figures 19-7, 19-8, and 19-9; Williams 2006). As a result, native aquatic species can experience additional temperature stress due to the river's altered flow and temperature regimes. However, where temperatures are cooler than they would be under a more natural flow regime (because of reservoir discharges of cold water through the summer), populations of *O. mykiss* (both anadromous and resident forms) are often able to persist at lower elevations than they would have historically. These areas are typically in the reaches immediately below dams.

In addition to the changes in water temperature due to reservoir storage, reservoirs and diversions also modify the temperature regime of downstream river reaches by diminishing the volume and thermal mass of water. A smaller quantity of water has less thermal mass and, therefore, a decreased ability to absorb temperatures from the surrounding environment (air and solar radiation) without being impacted (USACE 1987). The greatest impact typically occurs with less flow (less thermal mass) and warmer climate (increased solar radiation), usually in the late spring, summer, and early fall periods (DWR 2013). In highly altered systems such as the SJR Basin, channelization, levees, and loss of riparian habitat contribute to thermal loading which impacts water temperature and native fish species (Williams 2006; Moyle 2008).

On the Stanislaus, Tuolumne, and Merced Rivers water temperature is largely controlled by flow released from the reservoirs. For example, Figure 19-5 illustrates the relationship between average daily water temperature and average daily flow on the Tuolumne River during May at river mile 28.1 from 1980 to 2010 (modeled historic information from the SJR HEC-5Q model).

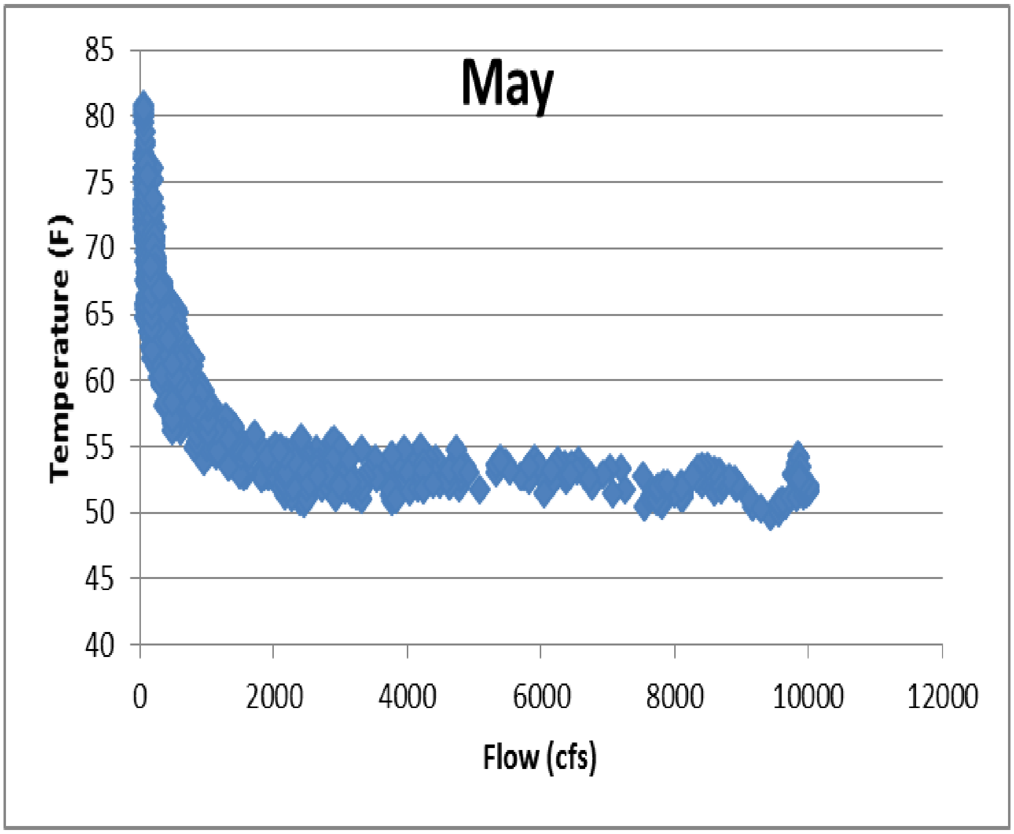

Figure 19-5. Average daily water temperature versus average daily flow relationship on the Tuolumne River during May at river mile 28.1 from 1980 to 2010 (modeled historic information from the SJR HEC-5Q model).

The remainder of this section describes the expected temperature benefits from increased flows during the February through June time period, and provides information as to why improved temperature conditions are important to native fish.

19.2.1 Importance of a Natural Temperature Regime in Aquatic Environments

Effects of Temperature on Aquatic Organisms

Water temperature is crucial to aquatic organisms because it directly influences their metabolism, respiration, feeding, growth, and reproduction. Most aquatic species have an optimal temperature range for growth and reproduction, and they are also bound by upper and lower limits in which they can no longer survive or successfully reproduce. Thus, their natural spatial and temporal distributions are largely determined by regional differences in temperatures driven by climate and elevation along with more local effects from riparian shading, groundwater influence, and other physical influences including flow alteration. Furthermore, water temperature can influence water chemistry, such as the solubility of oxygen in water (Carlisle et al. 2013).

Thermal stress to aquatic organisms can occur when a temperature or a change in temperature produces a significant change to biological functions leading to decreased likelihood of survival and reproduction. Thermal stress can lead to lethal effects either immediately, in a period of days, or even weeks or months from the onset of the elevated temperature. Thermal stress can also result in sublethal or indirect effects resulting in reduced fitness that impairs processes such as growth, spawning, or swimming speed. Metabolic processes are directly related to temperature, and the metabolic rate increases as a function of temperature (Marine and Cech 2004). Thus, aquatic organisms are most likely to thrive within their preferred range of temperatures (USEPA 2001a).

Effects of Temperature on Salmonids

Like other aquatic organisms, water temperatures significantly affect the distribution, health, and survival of native salmonids. Because salmonids are ectothermic (cold-blooded), their survival is dependent on external water temperatures and they will experience adverse effects when exposed to temperatures outside their optimal range. Salmonids have evolved and thrived under the water temperature patterns that historically existed (i.e., prior to significant anthropogenic impacts that altered temperature patterns) in streams and rivers. Although evidence suggests that historical water temperatures exceeded optimal conditions for Pacific salmonids at times, during the summer months on some rivers at some locations, the temperature diversity in these unaltered rivers provided sufficient access to cold water to allow salmonid populations as a whole to thrive (USEPA 2003). Across North America, human-caused elevated water temperatures significantly increase the magnitude, duration, and extent of thermal conditions unsuitable for salmonids (USEPA 2003).

The freshwater life histories of salmonids are closely tied to water temperatures. Cooling rivers in the autumn serve as a signal for upstream migrations. Fall spawning is initiated when water temperatures decrease to suitable temperatures. Eggs generally incubate over the winter or early spring when temperatures are coolest. Rising springtime water temperatures can serve as a cue for downstream migration (USEPA 2003).

Because of the overall importance of water temperature for salmonids in the Pacific Northwest, human-caused changes to natural temperature patterns have the potential to significantly reduce the size of salmonid populations. Of particular concern are human activities that have led to the excess warming of rivers, loss of temperature diversity (USEPA 2003), and the loss of access to coldwater habitats blocked by dams.

In the Central Valley, Myrick and Cech (2001 page iii) suggest that "water temperature is perhaps the physical factor with the greatest influence on Central Valley salmonids, short of a complete absence of water", and that "the changes made to Central Valley rivers have had, and will continue to have far-reaching effects on Chinook salmon and steelhead populations." The National Marine Fisheries Service (2009a) indicated that improving water temperatures in the Merced and Tuolumne Rivers (and many other Central Valley rivers) are key restoration actions for steelhead recovery in these watersheds. Additionally, NMFS (2009b) indicated that the primary limiting factor to the Central Valley steelhead distinct population segment (DPS) is the inaccessibility of more than 95% of its historic spawning and rearing habitat due to impassable dams, which among other factors, block access to cold water habitat found at higher elevations. The California Department of Fish and Game (2010a) indicated that rivers in the San Joaquin Basin do not meet (cool) temperature water quality criteria to protect anadromous fish beneficial uses, and that one critical factor limiting anadromous salmon and steelhead population abundance is high water temperatures which exist during critical life-stages in the tributaries and main-stem.

The following sections further discuss some of the specific mechanisms in which water temperature influences salmonids:

Influence of Temperature on Salmonid Behavior

Water temperature has the ability to influence the behavior of salmonids in several ways, including: causing movement to habitat with temperature refugia (e.g., stratified pools, shaded habitat, and subsurface flow), causing movement into areas with less cover but additional food resources (Nielsen et al. 1994; Torgersen et al. 1999; Myrick and Cech 2001; Torgersen et al. 2012), increasing competition between different fish species, changing metabolic rates, hindering the ability to avoid and evade predators, diminishing aquatic biodiversity, and increasing susceptibility of both juveniles and adults to certain parasites and diseases (Myrick and Cech 2001; Reese and Harvey 2002). As temperatures rise above optimal conditions, these modifications to behavior can be costly in terms of expending additional energy and increasing predation risk.

Influence of Temperature on Disease Risk in Salmonids

Chinook salmon are susceptible to a variety of different diseases, many of which have specific water temperature requirements (Boles et al. 1988). The effects of disease on salmonids is directly linked to water temperature, as water temperature greatly influences the immune system of fishes, and the quantity and virulence of water borne pathogens (Nichols and Foot 2002; Ferguson 1981). Although certain diseases become more prevalent in cold water environments, the more prevalent diseases that afflict Chinook salmon occur in warmer water temperatures (>56°F; Boles et al. 1988). Consequently, changes in water temperatures caused by dams and other water infrastructure can alter the susceptibility of salmonids to infection by various pathogens (Spence et al. 1996).

Disease adversely impacts fish populations by directly increasing mortality, and by indirectly contributing to increased susceptibility to predation and decreasing the ability of fish to perform essential functions, such as feeding, swimming, and defending territories (McCullough 1999; Nichols and Foott 2002). The susceptibility of salmonids to disease can also be affected by other stressors including insufficient dissolved oxygen, and chemical pollution. Temperature may interact synergistically with these factors, causing disease to appear in organisms that might be resistant in the absence of other forms of stress (Spence et al. 1996).

Diseased fish are present and have been caught in the Stanislaus, Tuolumne, Merced and San Joaquin Rivers. Naturally produced Chinook salmon juveniles caught in these rivers were infected with the causative agents of bacterial kidney disease (BKD) and proliferative kidney disease (PDK). These diseases and others can rapidly increase in the population as water temperature rises above the optimal temperature range of salmonids (Nichols and Foott 2002).

Flows have dilution effects on the presence of pathogens, flush diseases out of the ecosystem, and can lower water temperatures thus reducing disease outbreaks. Additionally, a greater amount of instream habitat affords individuals with a greater area in which to disperse and, consequently, there can be a lower probability of coming into close contact with diseased individuals (Spence et al. 1996).

Influence of Temperature on Predation Risk to Salmonids

In addition to disease, Chinook salmon juveniles are also increasingly vulnerable to predation as water temperatures increase. Predation on juvenile Chinook salmon is both directly and indirectly affected by water temperatures (Myrick and Cech 2001; McBain and Trush 2002). These direct and/or indirect impacts related to the influence of temperature on predation can add unnecessary stress to an already struggling salmonid population. First, direct effects can occur when water temperatures rise or fall to levels that alter the behavior of, or physically harm, the juvenile salmonid. An example of a direct effect is increasing water temperature that leads to premature utilization of the yolk sac by developing alevins, which may result in early emergence from the redd in an underdeveloped and vulnerable state. Second, the ability for a juvenile salmonid to maintain normal swimming abilities and adequately avoid predators is an important factor contributing to survival. Specifically, larval and early life-stage salmonids have relatively weak swimming abilities, making them particularly vulnerable to predation (McBain and Trush 2002). Increased temperatures may compound this effect. Third, increased water temperatures may decrease food availability, increase fish metabolic demand, and subsequently decrease growth rates and survival of salmonids (Boles et al. 1988). Increased water temperatures have the potential to drive salmon juveniles away from the more favorable and protective shallow water habitat (due to a limited food supply) into the main drift or deeper waters of the stream to forage for food. As Chinook salmon juveniles venture to more open instream habitats in search of food, they become an easier target for predatory fish who, in addition to salmon juveniles, need to sustain an increased metabolic demand for food as a result of warm water temperatures (Boles et al. 1988). Lastly, warm water temperatures can also increase vulnerability to predation by affecting the performance of juvenile Chinook salmon or by creating favorable conditions for predatory fish (Boles et al. 1988). As optimal water temperatures for salmonids are exceeded, many predatory fish are just beginning to enter their optimal water temperature range (CDFG 2010a). When water temperatures increase above preferred ranges, juvenile salmonids become stressed and potentially disoriented and erratic, which consequently causes them to become more vulnerable to increased predation rates (CDFG 2010a). Marine and Cech (2004) found that juvenile salmon that were reared in 21-24°C (69.8°F-75.2°F) were significantly more vulnerable to predation by striped bass than juvenile salmon reared at lower temperatures.

It is expected that restoring more natural temperature and flow regimes will help to better support the various life history adaptations of native fish and other native aquatic organisms, and may reduce predation from non-natives. The effectiveness of restoring the natural flow regime was demonstrated by Kiernan et al. (2012) in lower Putah Creek where a new flow regime was implemented that mimics the seasonal timing of natural increases and decreases in streamflow. Monitoring of several sites pre- and post- implementation of the new flow regime showed a change in the distribution of the native fish community. At the onset of the study, native fishes were constrained to habitat immediately (<1 km) below the diversion dam, and non-native species were numerically dominant at all downstream sample sites. Following implementation of the new flow regime, native fish populations expanded and regained dominance across more than 20 km of lower Putah Creek. The authors (Kiernan et al. 20012) proposed that that the expansion of native fishes was facilitated by creation of favorable spawning and rearing conditions (e.g., elevated springtime flows), cooler water temperatures, maintenance of lotic (flowing) conditions over the length of the creek, and displacement of alien species by naturally occurring high-discharge events.

Influence of Temperature on Adult Salmonid Migration

Adult salmonids migrate great distances in river systems throughout the Pacific Northwest, including the Central Valley. The success of these migrations can depend substantially on water temperatures. Most stocks of anadromous salmonids have evolved with the temperature regime of the streams they use for spawning and migration, and alteration of the normal temperature pattern can result in reduced fitness (USEPA 2001a).

If adult salmonid migration occurs at high temperatures just prior to spawning, gametes held internally in adults can be severely affected, resulting in a loss of viability that appears as poor fertilization or poor embryo survival (USEPA 2001a). Additionally, delayed migration caused by sub-optimal water temperatures may also affect the temperature conditions that the juvenile offspring will experience by pushing their in-river development further into the late spring or summer seasons during periods with higher temperatures. Furthermore, upstream migrating adult salmon that are delayed in the mainstem SJR and Delta can be subject to sport harvest, whereas adults that migrate into the tributaries are somewhat protected by sport fishing regulations that generally prohibit angling in the primary spawning reaches and times (Mesick 2001).

Thermal blockage to adult fall-run Chinook salmon migration was reported at a temperature of 21°C in the Sacramento-SJR Delta, but even temperatures as low as 19°C caused a partial blockage (Hallock et al. 1970).

Influence of Temperature on Salmonid Reproduction

Like with many other organisms, embryonic development of salmonids is a particularly important and sensitive life stage. Temperatures can influence salmonid egg development and success in a variety of ways. For example, sub-optimal temperatures can alter the formation of vertebrae in Central Valley Chinook salmon, and can cause direct mortality at high or low temperatures (Seymour 1959). Seymour (1956 as cited in DWR 1988) found that inadequate temperatures may not always lead to direct egg mortality, but can also cause mortality exceeding 50% of sac-fry (alevin) even when egg mortality was low. Additionally, even before eggs are deposited in gravels, exposure of adult females holding ripe eggs to warm water temperatures can cause egg mortality and can negatively alter egg and alevin development (Rice 1960 and Leitritz and Lewis 1976 as cited in McCullough 1999).

Chinook salmon have a narrow range of temperatures which lead to successful egg development. Myrick and Cech (2001) illustrated the effects of incubation temperature on direct mortality of Chinook salmon eggs from a variety of studies, as seen below in Figure 19-6.

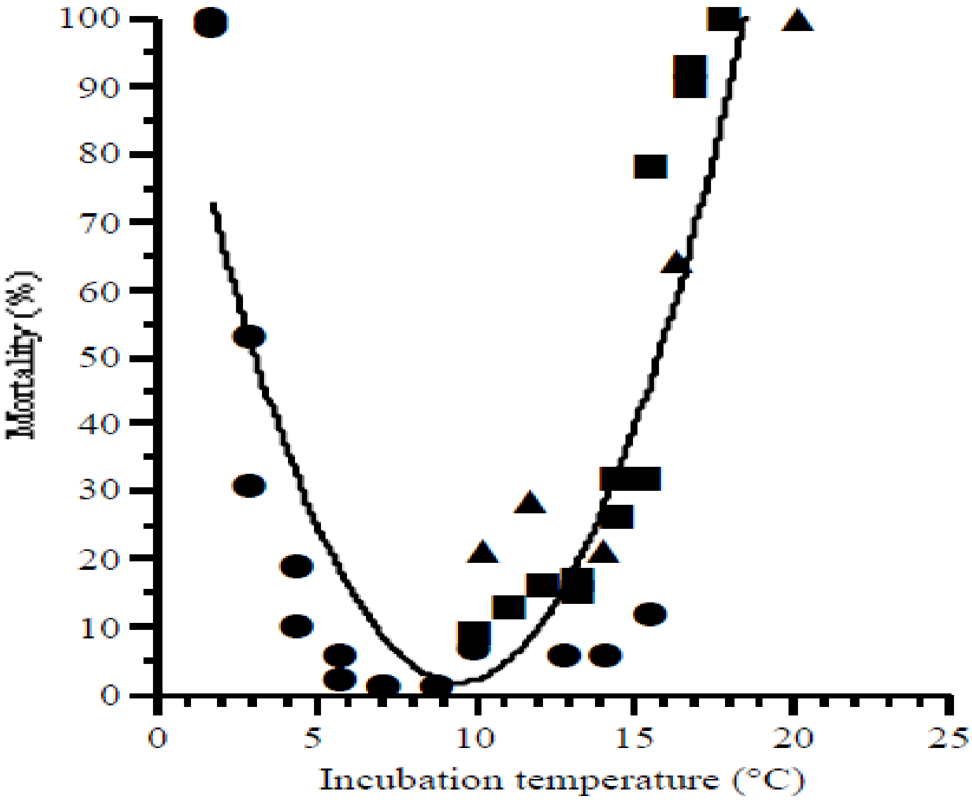

Figure 19-6. Myrick and Cech (2001) illustrate effects of incubation temperature on mortality of Chinook salmon eggs. Data are from Combs and Burrows (1957; solid circles), USFWS (1999; solid squares), and Jenson and Groot (1991; solid triangles).

With optimal conditions, Chinook salmon embryos hatch after 40-60 days and remain in the gravel as alevins for another 4-6 weeks, usually until the yolk sac is fully absorbed (Moyle et al 2008). Alevin are the life stage between eggs and fry, and these newly hatched salmon have not yet fully absorbed their yolk sac (NMFS 2009b). During this life stage alevin are still relatively sensitive to temperatures, with thermal requirements similar to those of eggs (USEPA 2001a, Myrick and Cech 2001).

Under existing conditions, elevated water temperatures appear to be impairing reproductive life-stages of salmonids in the SJR Basin, including its tributaries (CDFG 2010a). The magnitude in which poor temperatures effect the survival of incubating eggs, and ultimately population abundance, is currently unknown.

Influence of Temperature on Juvenile Salmonid Growth, Smoltification, and Emigration

Growth is perhaps the most powerful and complete integrator of environmental, behavioral, and physiological influences on a fish's fitness. Growth is the storage of excess energy and positive growth indicates an energy surplus, which is necessary to advance to and complete later life stages and ultimately complete successful reproduction (Myrick and Cech 2001).

Temperature affects growth directly through its effect on metabolic processes, and indirectly, through its effects on food availability and physical activity. Both Central Valley Chinook salmon and steelhead have high growth rates at temperatures approaching 19°C when they are fed to satiation in laboratory experiments. However, under partial food rations and reduced water quality, maximum growth rates occur at lower temperatures (Myrick and Cech 2001). Additionally, lower temperatures are required to complete the physiological and morphological adaptations that juvenile salmon undergo to transition from living in freshwater to living in saltwater, which is the process known as smoltification (Myrick and Cech 2001).

Freshwater fish are hypertonic to their environment and must actively excrete water and acquire ions (primarily Na+ and Cl-) (Moyle and Cech 2000 as cited in Myrick and Cech 2001). Marine fish are hypotonic (less salty than environment) and must drink copious quantities of sea water (Moyle and Cech 2000 as cited in Myrick and Cech 2001) and actively excrete salt (Myrick and Cech 2001). The smoltification process transforms salmonids from freshwater to saltwater physiology, which has high energetic costs associated with it (Cooperman et al. 2010; Gross et al. 1988, Sheridan et al. 1983). This costly transition suggests that the optimal habitats for growth, survival, and reproduction are necessary and separated spatially and/or seasonally (Northcote 1984). Survival of smolts upon reaching the marine environment depends heavily upon the degree of smoltification, and two of the most important factors regulating seawater adaptability of salmonids are freshwater rearing temperature and time of transfer to seawater (McCullough 1999). Additionally, it appears that the development of seawater tolerance in Chinook salmon and steelhead is partially a function of size (Clarke and Shelbourn 1985; Johnson and Clarke 1988), making it important that salmonids reach an appropriate size before they reach saltwater (Myrick and Cech 2001). Therefore, juvenile salmonids must grow large enough and have access to suitable temperature conditions to undergo the stress of completing the smoltification process and entering the ocean (Morinville and Rasmunsen 2003).

By controlling biochemical and physiological reaction rates, water temperature affects the physiological development of smolts, as well as the timing and duration of smoltification. Of particular significance is the inhibition of the gill ATPase osmoregulatory enzyme at high water temperatures, which leads to a loss of migratory behavior in salmonids (USEPA 2001b). Furthermore, warm water temperatures can decrease, arrest, or reverse the physiological function of smoltification, and subsequently delay the outmigration of juveniles into a more unfavorable timeframe (e.g., June; Boles et al. 1988; CDFG 2010a).

In addition to physiological impairment of smolts caused by elevated temperatures during migration, Baker et al. (1995) found that direct effects of high temperature explain a large part of the smolt mortality observed in the Delta. Additionally, using data from 1986–2010, Mesick (2012) evaluated the hypothesis that recruitment of naturally produced fall-run Chinook salmon in the major SJR tributaries was primarily a function of the suitability of water temperatures for smoltification. He found that the environmental variables that best explained variation in natural recruitment over the period of record were either mean flow in the mainstem SJR during the March 1 to April 30 parr migratory period or the number of days that water temperatures were less than a 15°C threshold for smoltification between March 1 and June 15 in the major SJR tributaries. Others (Baker et al 1995; CDFG 2010a; Kjelson et al 1982; Mesick 2010a) have also reached similar conclusions that temperature is one of the key limiting factors of smolt survival in the Central Valley.

Summary

The importance of suitable temperature habitats to aquatic organisms in the Central Valley has been well documented. Like other aquatic organisms, water temperature significantly affects the distribution, health, survival, and reproduction of native salmonids, and because salmonids are ectothermic (cold-blooded), their success is dependent on water temperature and they will experience adverse effects when exposed to temperatures outside their optimal range. In the Central Valley, water and land development has dramatically altered natural water temperature regimes available to many of California's native fish and wildlife. The following analysis will evaluate how increasing river discharge during February through June will improve temperature habitat relative to native salmonids in the Stanislaus, Tuolumne, Merced, and Lower San Joaquin Rivers.

19.2.2 Methods of Temperature Evaluation

This temperature analysis is based on predicted effects to key evaluation, or "indicator species." For this analysis, the indicator species used are Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and California Central Valley steelhead (*Oncorhynchus mykiss*). These indicator species were selected based on their sensitivity to potential changes in environmental conditions in the project area and their utility in evaluating broader ecosystem and community-level effects of these changes on native aquatic resources. The temperature requirements of Central Valley fall-run Chinook salmon and Central Valley steelhead are generally representative of the temperature requirements of other native fishes in the project area (see Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*).

Computer Modeling Used in Temperature Evaluation

To model effects on temperature in the LSJR and three eastside tributaries[2] for the SED, the State Water Board used the San Joaquin River Basin-Wide Water Temperature and EC Model (shorthand used here is SJR HEC-5Q model or temperature model) developed by a group of consultants between 2003 and 2008 through a series of CALFED contracts that included peer review and refinement (CALFED 2009). The temperature model was most recently updated by the CDFW and released in June of 2013 (CDFW 2013b).

The temperature model uses the Hydrologic Water Quality Modeling System (HWMS-HEC5Q), a graphical user interface that employs HEC-5Q, the USACE Hydrologic Engineering Center (HEC) flow and water quality simulation model, to model reservoir and river temperatures subject to historical climate conditions and user defined operations. The temperature model was designed to provide a SJR basin-wide evaluation of temperature response at 6-hour intervals for alternative conditions, such as operational changes, physical changes, and combinations of the two. The extent of the model includes the Merced, Tuolumne, and Stanislaus River systems from their LSJR confluences to the upstream end of their major reservoirs (i.e., McClure, Don Pedro, and New Melones, respectively). The upstream extent of the model on the LSJR is the Merced River confluence. The downstream extent of the model is the LSJR at Mossdale. The model simulates the reservoir stratification, release temperatures, and downstream river temperatures as a function of the inflow temperatures, reservoir geometry and outlets, flow, meteorology, and river geometry. Calibration data was used to accurately simulate temperatures for a range of reservoir operations, river flows, and meteorology.

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[2] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

The temperature model interfaces with CALSIM (see Appendix F.1, *Hydrologic and Water Quality Modeling*) or monthly data formatted similarly to CALSIM output. A pre-processing routine converts the monthly output to a format compatible with the SJR HEC-5Q model. This routine serves two purposes: 1) to allow the temperature model to perform a long-term simulation compatible with the period used in CALSIM II, and 2) to convert monthly output to daily values used in the temperature model.

Using the monthly output from the Water Supply Effects (WSE) model (see Appendix F.1), the "CALSIM to HEC-5Q" temperature model pre-processor was used by the State Water Board, and the temperature model was run to determine the river temperature effects of different flow scenarios within the Stanislaus, Tuolumne, Merced, and Lower San Joaquin Rivers. The temperature model was run for the period 1970 through 2003, a period with sufficient length and climatic variation to determine the effects of the LSJR alternatives on river temperatures.

Temperature Criteria Used in Evaluation

The temperature thresholds used in this evaluation are based on the U.S. Environmental Protection Agency (USEPA) recommended temperature criteria for protection of salmonids using the 7-day average of the daily maximum (7DADM) unit of measurement (USEPA 2003). The 7DADM metric is recommended by USEPA because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. Thus, it reflects an average of maximum temperatures that fish are exposed to over a week-long period. Because this metric is oriented to daily maximum temperatures, it can be used to protect against acute effects such as lethality and migration blockage conditions and also to protect against sub-lethal or chronic effects (e.g., temperature effects on growth, disease, smoltification, and competition) (USEPA 2003).

For this temperature evaluation of the Bay-Delta Plan update, USEPA's recommended criteria were used as a benchmark to measure changes in protective temperature conditions for Central Valley fall-run Chinook salmon and Central Valley steelhead under a variety of unimpaired flows. These protective temperature criteria represent the upper limits of the optimal temperature range for each evaluated life stage. The percentage of days during each month over the modeled 34-year period (1970-2003; n= number of days per specific month multiplied by 34 years) that USEPA criteria are expected to be met at each river location identified in Table 19-1 and Table 19-2 were used to quantify changes between baseline conditions and the conditions resulting from the modeled unimpaired flows. A 10% change in the amount of time that USEPA criteria is met, in combination with professional judgment, is used to determine a significant benefit or impact. Ten percent was selected because it accounts for a reasonable range of potential error associated with the assumptions used in the various analytical and modeling techniques. In addition, lacking quantitative relationships between a given change in environmental conditions and relevant population metrics (e.g., survival or abundance), a 10% change was considered sufficient to potentially result in beneficial or adverse effects to sensitive species at the population level.

Additionally, the average daily 7DADM values for each month (n= number of days per specific month multiplied by 34 years), and the 90th percentile daily 7DADM values for each month (n= number of days per specific month multiplied by 34 years) were evaluated for both baseline and unimpaired flows during the 34-year temperature model period. The 90th percentile temperature represents the 7DADM value in which temperatures are lower 90% of the time and temperatures are higher 10% of the time. These two temperature metrics provide additional insight into expected effects on native salmonids from different unimpaired flows.

Life Stage Timing Used in Temperature Evaluation

This evaluation focuses on the most sensitive and relatively abundant salmonid species and life stages during each given time period. The life stage timings which were used are based on the general distribution and abundance of each life stage in the rivers. For example, water temperatures at locations approximately three-quarters of the distance from the mouth of each tributary to the first impassable dam were used to characterize water temperatures in the primary Chinook salmon and steelhead spawning reaches. This location was selected because it generally represents conditions in the spawning reaches, and therefore reflects water temperatures available for spawning and incubation. Table 19-1 provides a summary of the primary points of reference used for this comparative temperature analysis (between baseline and different unimpaired flows) in the Stanislaus, Tuolumne, and Merced Rivers.

On the LSJR, similar life stage timing was used as in the tributaries, except that spawning, egg incubation, and fry emergence were not used because salmonid reproduction typically does not take place in the LSJR, currently. Instead, the adult migration life stage was used during September through December, and the core juvenile rearing life stage was used during January through March. Table 19-2 provides a summary of the points of reference used for this comparative temperature analysis (between baseline and different unimpaired flow cases) in the LSJR.

Table 19-1. Primary Stanislaus, Tuolumne, and Merced River fall-run Chinook salmon and steelhead (composite) temperature evaluation considerations. For the primary evaluation locations, the anadromous portion of the river was split into quarters, with ¼ River being closer to the confluence and ¾ River being closer to the dam that limits anadromous migrations.

Evaluation Time Period	Primary Life Stage (fall-run Chinook and steelhead composite)	Temperature Evaluation Thresholds (°C)	Temperature Evaluation Thresholds (°F)	Primary Evaluation Locations
September 1 to October 31	Adult Migration	18 (7DADM)	64.4 (7DADM)	Confluence ¼ River ½ River
October 1 to March 31	Spawning, Egg Incubation, and Fry Emergence	13 (7DADM)	55.4 (7DADM)	½ River ¾ River Dam
March 1 to May 31	Core Juvenile Rearing	16 (7DADM)	60.8 (7DADM)	Confluence ¼ River ½ River ¾ River Dam
April 1 to June 30	Smoltification	14 (7DADM)	57.2 (7DADM)	Confluence ¼ River ½ River
June 1 to August 31	Summer Rearing	18 (7DADM)	64.4 (7DADM)	½ River ¾ River Dam

Table 19-2. Primary Lower San Joaquin River fall-run Chinook salmon and steelhead (composite) temperature evaluation considerations.

Evaluation Time Period	Primary Life Stage (fall-run Chinook and steelhead composite)	Temperature Evaluation Thresholds (°C)	Temperature Evaluation Thresholds (°F)	Primary Evaluation Locations
September 1 to December 31	Adult Migration	18 (7DADM)	64.4 (7DADM)	Vernalis
January 1 to March 31	Core Juvenile Rearing	16 (7DADM)	60.8 (7DADM)	Vernalis
April 1 to June 30	Smoltification	14 (7DADM)	57.2 (7DADM)	Vernalis

19.2.3 Results of Temperature Evaluation

Based on this evaluation and the conclusions and discussions of others (Baker et al. 1995; Brandes and McLain 2001; CDFG 2005b, 2010a; Kjelson et al 1982; Kjelson and Brandes 1989; Marine and Cech 2004; Mesick 2010a; Myrick and Cech 2001; NMFS 2009a; Zeug et al. 2014), existing baseline temperature conditions in the Bay-Delta Plan area including the Stanislaus, Tuolumne, and Merced Rivers are likely to be detrimental to salmonids, and other native fishes, that use these waterways. Temperature conditions in September, October, and November are often poor at many locations used by adult migrating and spawning salmon. Furthermore, fry emergence, rearing, smoltification, and emigration life stages are also exposed to suboptimal and even harmful temperature conditions from roughly March through June during many years. Finally, salmonids that stay in the rivers to over summer between June and September have little chance of thriving unless they find the little cold water refugia that potentially exists (depending on the year and river) directly below the dams.

The results of this analysis indicate that significant temperature benefits to Central Valley fall-run Chinook salmon and Central Valley steelhead will occur on the Stanislaus, Tuolumne, Merced, and LSJ Rivers under some of the unimpaired flow alternatives which were evaluated. Significant temperature improvements in the Stanislaus River primarily occur under 50%-60% unimpaired flows, and in the Merced River primarily occur under 30%-60% unimpaired flows. Significant temperature improvements in the Tuolumne River occur under all alternative unimpaired flows with the least benefit occurring under 20% unimpaired flow and the most benefit occurring under 60% unimpaired flow. However, modeling results indicate that significant temperature benefits to the smoltification life stage will occur only with 50% and 60% unimpaired flows on the Stanislaus and Merced Rivers during April and May (Tables 19-3 and 19-9). In the LSJR, significant temperature improvements to the availability of optimal conditions occur during March under the 60% unimpaired flow, with other months and other unimpaired flows not expected to produce significant benefits or impacts on optimal salmonid temperature habitat. Although there are limited benefits to optimal salmonid temperature habitat in the LSJR, there are substantial reductions in average temperatures and 90th percentile temperatures primarily during the March through June time period with higher unimpaired flows providing greater reductions to these measures of temperature.

It is important to note that interpretations of the results do not place too much emphasis on temperature criteria compliance at the dam release locations, because releasing small amounts of cold water can indicate that adequate temperature habitat exists, but may not actually provide favorable conditions for native fish in these rivers due to rapid warming as the water flows downstream under low flow conditions. A better location to evaluate temperature during many months in each river is near the ¾ river location, or further downstream. However, there is information that can be gathered from the temperatures at the dam releases. For example, the temperature of water at the dam release can indicate whether or not there is cold water available for release.

The remainder of this section provides an interpretation of the results presented in Tables 19-3 through 19-14, and is organized in sections specific to each evaluation time period, life stage, and location.

Table 19-3. The percentage of time on the Stanislaus River that USEPA salmon and steelhead temperature criteria (7DADM unit of measurement) are met each month under modeled baseline (base) conditions during 1970 to 2003, and the magnitude of expected percent change under modeled unimpaired flows of 20%, 30%, 40%, 50% and 60% at different river mile (RM) locations. Positive numbers under the unimpaired flows represent the magnitude of increases compared to baseline in the percentage of time that criteria are expected to be met, and negative numbers under the unimpaired flows represent the magnitude of reductions compared to baseline in the percentage of time that criteria are expected to be met. Expected changes in the amount of time that USEPA temperature criteria are met which are greater than positive 10% or less than negative 10% are highlighted green or red respectively (if applicable), and represent significant changes to salmon and steelhead temperature habitat if indicated at locations which are utilized by that life stage.

Stanislaus River		**Confluence (RM0)**						**1/4 River (RM13.3)**						**1/2 River (RM28.2)**						**3/4 River (RM43.7)**						**Below Goodwin (RM58.5)**					
Life Stage	Month / USEPA Criteria (°F)	**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**				
			20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
AM	Sep (64.4)	**10%**	0%	0%	2%	0%	-2%	**11%**	0%	0%	8%	6%	4%	**17%**	2%	0%	14%	13%	11%	**67%**	3%	-1%	-1%	-1%	-6%	**88%**	12%	12%	12%	12%	12%
AM	Oct (64.4)	**71%**	7%	6%	12%	11%	11%	**75%**	8%	7%	12%	12%	10%	**82%**	9%	8%	11%	11%	10%	**87%**	11%	11%	12%	11%	11%	**88%**	12%	12%	12%	12%	12%
R	Oct (55.4)	**3%**	0%	-1%	-3%	-3%	-3%	**3%**	0%	0%	-2%	-2%	-3%	**5%**	0%	0%	1%	0%	-2%	**17%**	0%	0%	2%	-2%	-4%	**55%**	4%	1%	-2%	-5%	-9%
R	Nov (55.4)	**27%**	2%	2%	3%	1%	0%	**27%**	2%	1%	3%	1%	-1%	**36%**	2%	0%	2%	-1%	-4%	**45%**	6%	1%	3%	0%	-4%	**64%**	5%	1%	1%	2%	-4%
R	Dec (55.4)	**99%**	1%	1%	1%	1%	1%	**99%**	1%	1%	1%	1%	1%	**97%**	3%	3%	3%	3%	3%	**95%**	4%	4%	5%	5%	4%	**90%**	6%	6%	8%	7%	7%
R	Jan (55.4)	**99%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	0%
R	Feb (55.4)	**85%**	2%	3%	3%	4%	6%	**85%**	2%	3%	4%	5%	7%	**93%**	1%	0%	1%	2%	3%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%
R	Mar (55.4)	**36%**	7%	9.9%	9.6%	16%	21%	**41%**	4%	9%	9.96%	16%	21%	**53%**	0%	7%	12%	16%	22%	**78%**	-1%	4%	11%	14%	17%	**100%**	0%	0%	0%	0%	0%
CR	Mar (60.8)	**91%**	-1%	2%	5%	7%	8%	**92%**	-1%	4%	5%	7%	7%	**97%**	-1%	2%	2%	3%	3%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%
CR	Apr (60.8)	**78%**	-2%	1%	3%	9.9%	13%	**81%**	-1%	1%	8%	11%	13%	**90%**	0%	5%	7%	8%	8%	**99%**	1%	1%	1%	1%	1%	**100%**	0%	0%	0%	0%	0%
CR	May (60.8)	**51%**	-2%	4%	6%	14%	22%	**61%**	-1%	3%	7%	12%	18%	**73%**	1%	6%	9.7%	11%	13%	**94%**	2%	2%	3%	5%	6%	**100%**	0%	0%	0%	0%	0%
S	Apr (57.2)	**39%**	-2%	-1%	1%	5%	9.7%	**45%**	1%	2%	3%	8%	11%	**64%**	-1%	0%	2%	4%	9%	**85%**	1%	6%	8%	11%	12%	**99%**	1%	1%	1%	1%	1%
S	May (57.2)	**5%**	-2%	0%	2%	8%	17%	**13%**	-4%	-1%	2%	11%	22%	**31%**	-6%	0%	7%	16%	22%	**67%**	2%	3%	7%	10%	13%	**97%**	3%	3%	3%	3%	3%
S	Jun (57.2)	**0%**	0%	0%	1%	5%	7%	**3%**	0%	0%	1%	5%	6%	**5%**	0%	3%	4%	8%	13%	**27%**	-3%	-1%	2%	11%	17%	**96%**	2%	0%	1%	-1%	-2%
SR	Jun (64.4)	**38%**	-1%	1%	3%	12%	19%	**47%**	-4%	-2%	2%	11%	17%	**56%**	-2%	3%	7%	12%	15%	**81%**	3%	4%	5%	5%	7%	**100%**	0%	0%	0%	0%	0%
SR	Jul (64.4)	**5%**	0%	2%	2%	3%	4%	**8%**	-2%	2%	0%	1%	3%	**12%**	-1%	4%	4%	5%	7%	**43%**	3%	4%	9%	8%	8%	**100%**	0%	0%	0%	0%	0%
SR	Aug (64.4)	**5%**	2%	0%	-2%	-2%	-4%	**6%**	2%	-1%	-3%	-3%	-3%	**8%**	0%	-2%	-5%	-5%	-5%	**47%**	3%	-2%	1%	-1%	-7%	**96%**	4%	4%	4%	4%	4%

AM = Adult Migration
R = Reproduction (Spawning, Egg Incubation, and Fry Emergence)
CR = Core Rearing
S = Smoltification
SR = Summer Rearing

Table 19-4. The average daily 7DADM temperature values for each month on the Stanislaus River under modeled baseline (base) condition from 1970 to 2003, and the modeled difference in °F for each of the unimpaired flow percentages between 20% to 60%. Negative numbers represent the expected magnitude of reductions in 7DADM values and positive numbers represent the expected magnitude of increases in 7DADM values. Expected changes in the magnitude of 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

Stanislaus Average 7DADM	Confluence (RM0)						1/4 River (RM13.3)						1/2 River (RM28.2)						3/4 River (RM43.7)						Below Goodwin (RM58.5)					
	Base (°F)	Percent Unimpaired Flow					**Base (°F)**	Percent Unimpaired Flow					**Base (°F)**	Percent Unimpaired Flow					**Base (°F)**	Percent Unimpaired Flow					**Base (°F)**	Percent Unimpaired Flow				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	**69.6**	-0.2	0.0	-0.5	-0.3	-0.1	**68.9**	-0.3	-0.1	-0.6	-0.4	-0.2	**67.3**	-0.4	-0.2	-0.7	-0.5	-0.2	**63.4**	-0.7	-0.5	-0.9	-0.7	-0.3	**56.6**	-1.2	-0.9	-0.8	-0.6	-0.1
Oct	**62.0**	-0.6	-0.4	-1.2	-1.1	-0.9	**61.5**	-0.7	-0.5	-1.2	-1.1	-0.9	**60.4**	-0.8	-0.6	-1.3	-1.1	-0.9	**58.7**	-1.0	-0.8	-1.2	-1.1	-0.8	**56.4**	-1.3	-1.0	-1.2	-1.0	-0.7
Nov	**56.8**	-0.4	-0.3	-0.4	-0.3	-0.2	**56.8**	-0.4	-0.3	-0.4	-0.3	-0.2	**56.6**	-0.5	-0.4	-0.5	-0.4	-0.3	**56.2**	-0.7	-0.6	-0.7	-0.6	-0.4	**55.6**	-1.0	-0.8	-0.9	-0.8	-0.5
Dec	**50.9**	-0.1	-0.1	-0.1	-0.1	0.0	**51.1**	-0.2	-0.1	-0.1	-0.1	0.0	**51.2**	-0.2	-0.2	-0.2	-0.1	-0.1	**51.8**	-0.3	-0.2	-0.3	-0.2	-0.1	**52.3**	-0.4	-0.3	-0.3	-0.3	-0.2
Jan	**49.8**	0.0	0.0	0.0	0.0	0.0	**50.0**	0.0	0.0	0.0	0.0	0.0	**49.8**	-0.1	0.0	-0.1	0.0	0.0	**49.6**	-0.1	0.0	-0.1	-0.1	0.0	**49.0**	-0.1	0.0	-0.1	-0.1	-0.1
Feb	**52.5**	-0.1	-0.3	-0.5	-0.6	-0.8	**52.5**	-0.2	-0.4	-0.6	-0.7	-0.9	**51.9**	-0.2	-0.4	-0.5	-0.7	-0.8	**50.7**	-0.1	-0.2	-0.3	-0.4	-0.5	**48.8**	0.0	0.1	0.1	0.1	0.1
Mar	**56.5**	-0.1	-0.5	-0.7	-1.1	-1.5	**56.2**	-0.2	-0.6	-0.8	-1.2	-1.6	**55.2**	-0.2	-0.6	-0.8	-1.2	-1.6	**53.4**	-0.1	-0.4	-0.6	-0.8	-1.0	**50.5**	0.1	0.0	0.1	0.0	0.0
Apr	**58.5**	0.1	-0.1	-0.3	-0.7	-1.1	**57.9**	0.1	-0.1	-0.3	-0.7	-1.0	**56.6**	0.1	-0.1	-0.3	-0.6	-0.9	**54.7**	0.1	-0.1	-0.2	-0.4	-0.5	**51.8**	0.1	0.0	0.0	0.0	0.0
May	**61.5**	0.0	-0.4	-0.8	-1.4	-2.1	**60.8**	0.0	-0.4	-0.8	-1.4	-2.0	**59.1**	0.0	-0.4	-0.7	-1.2	-1.7	**56.6**	0.0	-0.3	-0.4	-0.8	-1.1	**53.0**	0.0	0.0	0.0	-0.1	-0.2
Jun	**66.8**	0.1	-0.4	-0.8	-1.6	-2.4	**66.0**	0.1	-0.4	-0.8	-1.7	-2.4	**64.1**	0.0	-0.4	-0.9	-1.6	-2.2	**60.3**	-0.1	-0.4	-0.7	-1.2	-1.6	**53.8**	-0.1	0.0	-0.1	0.0	0.0
Jul	**72.8**	-0.1	-0.4	-0.9	-1.0	-1.1	**72.0**	-0.1	-0.4	-0.9	-1.0	-1.1	**70.0**	-0.2	-0.5	-1.0	-1.1	-1.1	**64.8**	-0.3	-0.4	-0.9	-0.9	-0.8	**55.0**	-0.3	-0.1	-0.1	0.1	0.3
Aug	**73.0**	-0.3	-0.1	0.0	0.1	0.3	**72.2**	-0.3	-0.1	-0.1	0.0	0.3	**70.2**	-0.4	-0.1	-0.1	0.0	0.2	**65.0**	-0.6	-0.3	-0.3	-0.1	0.2	**55.8**	-0.7	-0.5	-0.4	-0.1	0.4

Table 19-5. The 90th percentile daily 7DADM temperature values for the 1970 to 2003 model period for each month at different Stanislaus River locations, and the expected difference in °F for each of the unimpaired flow percentages between 20% and 60%. Each of the 90th percentile values which are displayed for baseline (base) indicate that daily 7DADM values were less than that temperature 90% of the time, or were greater than that temperature 10% of the time during each month and river location. Expected changes in the magnitude of 90th percentile 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

Stanislaus 90th Percentile 7DADM	**Confluence (RM0)**						**1/4 River (RM13.3)**						**1/2 River (RM28.2)**						**3/4 River (RM43.7)**						**Below Goodwin (RM58.5)**					
	Base (°F)	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	**74.3**	-0.4	-0.4	-0.5	-0.4	-0.3	**74.1**	-0.8	-0.7	-0.8	-0.7	-0.5	**73.3**	-1.4	-1.4	-1.5	-1.4	-1.2	**70.2**	-3.1	-2.9	-3.1	-3.0	-2.8	**65.5**	-6.5	-6.3	-6.4	-6.1	-5.9
Oct	**68.2**	-1.2	-1.1	-2.1	-2.0	-1.8	**67.7**	-1.7	-1.5	-2.6	-2.4	-2.2	**66.9**	-2.7	-2.5	-3.5	-3.4	-3.2	**66.2**	-5.3	-5.0	-5.8	-5.7	-5.3	**65.9**	-7.6	-7.5	-8.1	-7.9	-7.8
Nov	**60.5**	-0.6	-0.5	-0.9	-0.9	-0.9	**60.3**	-0.6	-0.6	-0.9	-0.9	-0.8	**59.9**	-0.7	-0.6	-0.9	-0.8	-0.8	**60.2**	-2.0	-1.9	-2.1	-2.1	-2.0	**60.9**	-3.7	-3.5	-3.9	-4.0	-4.0
Dec	**53.6**	-0.3	-0.3	-0.2	-0.2	-0.1	**53.8**	-0.4	-0.3	-0.3	-0.2	-0.2	**53.9**	-0.5	-0.4	-0.4	-0.3	-0.2	**54.5**	-0.8	-0.6	-0.6	-0.6	-0.5	**55.5**	-1.1	-0.9	-1.1	-1.1	-1.0
Jan	**52.2**	-0.1	-0.1	-0.1	0.0	0.1	**52.3**	-0.1	0.0	-0.1	-0.1	0.1	**52.1**	-0.1	-0.1	-0.1	0.0	0.0	**51.7**	-0.2	-0.1	-0.1	-0.1	0.0	**51.1**	-0.3	-0.2	-0.3	-0.3	-0.2
Feb	**56.1**	0.0	-0.1	-0.2	-0.5	-0.8	**56.0**	-0.3	-0.3	-0.5	-0.8	-1.1	**55.1**	-0.2	-0.3	-0.4	-0.7	-1.1	**53.2**	0.0	-0.1	-0.2	-0.4	-0.6	**50.7**	0.1	0.1	0.0	0.1	0.1
Mar	**60.6**	0.3	-0.3	-0.8	-1.5	-2.2	**60.4**	0.2	-0.7	-1.2	-2.0	-2.7	**59.4**	0.2	-0.8	-1.3	-2.1	-2.7	**56.5**	0.3	-0.6	-1.0	-1.4	-1.8	**52.6**	0.2	0.1	0.0	0.0	0.0
Apr	**63.1**	0.2	-0.8	-1.4	-1.8	-2.4	**62.4**	0.3	-0.8	-1.5	-1.8	-2.3	**60.8**	0.2	-0.8	-1.4	-1.8	-2.2	**57.7**	0.0	-0.5	-0.9	-1.2	-1.3	**53.9**	-0.2	-0.3	-0.2	-0.2	-0.2
May	**66.4**	-0.3	-1.2	-1.5	-1.6	-2.2	**65.5**	-0.2	-1.1	-1.3	-1.5	-2.0	**63.6**	-0.1	-1.1	-1.3	-1.3	-1.9	**60.2**	-0.3	-0.9	-0.9	-1.0	-1.4	**54.9**	0.0	0.0	0.0	-0.1	-0.2
Jun	**73.3**	-0.1	-0.3	-0.3	-0.6	-1.0	**72.9**	-0.5	-0.4	-0.4	-0.8	-1.2	**71.5**	-0.7	-0.8	-0.6	-1.2	-1.6	**66.5**	-0.8	-0.8	-0.9	-1.5	-1.7	**56.2**	-0.1	0.2	-0.1	0.0	0.3
Jul	**77.4**	-0.3	-0.2	-0.3	-0.4	-0.4	**76.9**	-0.3	-0.3	-0.5	-0.5	-0.5	**75.3**	-0.5	-0.4	-0.6	-0.6	-0.5	**69.4**	-0.5	-0.4	-0.6	-0.5	-0.4	**57.8**	-0.4	-0.1	0.2	0.6	0.8
Aug	**76.9**	-0.3	-0.2	-0.4	-0.4	-0.3	**76.4**	-0.4	-0.3	-0.6	-0.4	-0.3	**75.0**	-0.6	-0.5	-0.9	-0.8	-0.7	**70.3**	-1.6	-1.4	-1.7	-1.6	-1.5	**60.6**	-2.6	-1.8	-1.7	-1.3	-1.1

Table 19-6. The percentage of time on the Tuolumne River that USEPA salmon and steelhead temperature criteria (7DADM unit of measurement) are met each month under modeled baseline (base) conditions during 1970 to 2003, and the magnitude of expected percent change under modeled unimpaired flows of 20%, 30%, 40%, 50% and 60% at different river mile (RM) locations. Positive numbers under the unimpaired flows represent the magnitude of increases compared to baseline in the percentage of time that criteria are expected to be met, and negative numbers under the unimpaired flows represent the magnitude of reductions compared to baseline in the percentage of time that criteria are expected to be met. Expected changes in the amount of time that USEPA temperature criteria are met which are greater than positive 10% or less than negative 10% are highlighted green or red respectively (if applicable), and represent significant changes to salmon and steelhead temperature habitat if indicated at locations which are utilized by that life stage.

Tuolumne River		**Confluence (RM0)**						**1/4 River (RM13.2)**						**1/2 River (RM28.1)**						**3/4 River (RM38.3)**						**Below La Grange (RM53.5)**					
Life Stage	Month / USEPA Criteria (°F)	**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**				
			20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
AM	Sep (64.4)	**2%**	0%	0%	0%	0%	0%	**3%**	0%	0%	2%	2%	1%	**11%**	0%	-2%	17%	17%	16%	**33%**	0%	-3%	7%	6%	6%	**100%**	0%	0%	0%	0%	0%
AM	Oct (64.4)	**25%**	0%	-1%	6%	5%	6%	**37%**	0%	-1%	4%	3%	3%	**63%**	0%	0%	3%	4%	4%	**81%**	1%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%
R	Oct (55.4)	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**1%**	0%	-1%	-1%	-1%	-1%	**85%**	3%	3%	3%	4%	-2%
R	Nov (55.4)	**27%**	0%	0%	1%	0%	-1%	**34%**	0%	0%	1%	-1%	-2%	**23%**	0%	-1%	-1%	-4%	-5%	**27%**	0%	-2%	-3%	-9%	-9%	**85%**	4%	4%	5%	6%	0%
R	Dec (55.4)	**98%**	0%	0%	0%	0%	0%	**100%**	0%	0%	-1%	-1%	-1%	**95%**	0%	0%	0%	-1%	-2%	**93%**	1%	0%	0%	-2%	-2%	**95%**	1%	1%	1%	1%	-2%
R	Jan (55.4)	**98%**	0%	0%	0%	0%	0%	**98%**	0%	0%	0%	0%	0%	**97%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	-1%	**99%**	0%	0%	0%	0%	0%
R	Feb (55.4)	**69%**	2%	3%	6%	8%	10%	**75%**	3%	5%	6%	8%	9.9%	**72%**	5%	8%	9.8%	14%	18%	**79%**	1%	4%	9.99%	12%	13%	**100%**	0%	0%	0%	0%	0%
R	Mar (55.4)	**37%**	-3%	-3%	-3%	-1%	9%	**50%**	-1%	0%	2%	7%	12%	**54%**	5%	8%	14%	22%	27%	**56%**	9%	14%	25%	30%	35%	**100%**	0%	0%	0%	0%	0%
CR	Mar (60.8)	**65%**	6%	8%	18%	24%	28%	**72%**	5%	11%	20%	23%	25%	**84%**	9%	14%	15%	15%	16%	**91%**	8%	9%	9%	9%	9%	**100%**	0%	0%	0%	0%	0%
CR	Apr (60.8)	**50%**	0%	6%	21%	35%	41%	**57%**	4%	18%	31%	36%	38%	**74%**	16%	22%	22%	24%	25%	**92%**	6%	6%	7%	8%	8%	**100%**	0%	0%	0%	0%	0%
CR	May (60.8)	**19%**	2%	20%	34%	47%	37%	**34%**	9%	32%	46%	52%	58%	**59%**	21%	30%	39%	41%	41%	**74%**	14%	24%	26%	26%	26%	**100%**	0%	0%	0%	0%	0%
S	Apr (57.2)	**22%**	0%	2%	5%	9%	15%	**36%**	-2%	2%	7%	21%	31%	**57%**	3%	16%	28%	34%	37%	**65%**	14%	25%	29%	30%	31%	**100%**	0%	0%	0%	0%	0%
S	May (57.2)	**3%**	0%	1%	2%	4%	3%	**15%**	3%	9%	16%	30%	40%	**38%**	9%	26%	39%	43%	46%	**56%**	14%	28%	35%	40%	43%	**100%**	0%	0%	0%	0%	0%
S	Jun (57.2)	**0%**	0%	0%	0%	0%	0%	**5%**	1%	1%	2%	5%	10%	**23%**	-1%	6%	13%	21%	23%	**34%**	8%	20%	31%	37%	39%	**100%**	0%	0%	0%	0%	0%
SR	Jun (64.4)	**30%**	1%	11%	24%	35%	36%	**34%**	7%	25%	33%	41%	42%	**42%**	24%	33%	37%	45%	48%	**46%**	29%	37%	45%	45%	47%	**100%**	0%	0%	0%	0%	0%
SR	Jul (64.4)	**6%**	-1%	0%	1%	1%	-1%	**19%**	0%	-2%	0%	-2%	-4%	**23%**	2%	-2%	16%	17%	14%	**26%**	3%	-3%	15%	16%	16%	**100%**	0%	0%	0%	0%	0%
SR	Aug (64.4)	**0%**	0%	0%	0%	0%	0%	**2%**	0%	0%	-1%	-1%	-2%	**8%**	0%	0%	1%	1%	0%	**9%**	0%	-1%	8%	6%	5%	**100%**	0%	0%	0%	0%	0%

AM =	Adult Migration
R =	Reproduction (Spawning, Egg Incubation, and Fry Emergence)
CR =	Core Rearing
S =	Smoltification
SR =	Summer Rearing

Table 19-7. The average daily 7DADM temperature values for each month on the Tuolumne River under modeled baseline (base) condition from 1970 to 2003, and the modeled difference in °F for each of the unimpaired flow percentages between 20% to 60%. Negative numbers represent the expected magnitude of reductions in 7DADM values and positive numbers represent the expected magnitude of increases in 7DADM values. Expected changes in the magnitude of 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

Tuolumne Average 7DADM	Confluence (RM0)						1/4 River (RM13.2)						1/2 River (RM28.1)						3/4 River (RM38.3)						Below La Grange (RM53.5)					
	Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	**75.5**	0.0	0.1	-1.1	-1.1	-1.0	**74.9**	0.0	0.1	-1.2	-1.2	-1.1	**70.9**	0.0	0.2	-1.1	-1.0	-1.0	**68.3**	0.0	0.2	-0.8	-0.7	-0.7	**53.5**	0.0	0.2	0.4	0.6	0.6
Oct	**67.5**	0.0	0.1	-0.5	-0.5	-0.5	**66.5**	0.0	0.2	-0.5	-0.4	-0.4	**63.3**	0.0	0.2	-0.3	-0.2	-0.2	**61.3**	0.0	0.2	-0.1	0.0	0.0	**53.8**	-0.1	0.1	0.3	0.5	0.5
Nov	**57.8**	0.0	0.0	-0.2	-0.1	-0.1	**56.9**	0.0	0.0	-0.1	0.0	0.0	**57.2**	0.0	0.1	0.0	0.1	0.1	**56.7**	0.0	0.1	0.0	0.1	0.1	**53.7**	-0.1	0.0	0.3	0.4	0.4
Dec	**50.2**	0.0	0.0	0.0	0.0	0.0	**49.6**	0.0	-0.1	0.0	0.0	0.0	**52.6**	0.0	0.0	0.1	0.2	0.2	**53.3**	0.0	0.0	0.2	0.2	0.2	**52.9**	0.0	0.0	0.2	0.3	0.3
Jan	**50.0**	0.0	0.0	0.0	0.0	0.0	**49.4**	0.0	0.0	-0.1	0.0	0.0	**51.9**	0.0	0.1	0.1	0.2	0.2	**52.2**	0.0	0.1	0.2	0.2	0.2	**51.0**	0.0	0.0	0.1	0.1	0.1
Feb	**54.2**	-0.1	-0.2	-0.3	-0.4	-0.7	**53.3**	-0.1	-0.2	-0.3	-0.5	-0.7	**53.6**	-0.1	-0.4	-0.5	-0.8	-1.0	**53.1**	-0.1	-0.4	-0.5	-0.7	-1.0	**50.0**	0.0	0.0	0.0	-0.1	-0.1
Mar	**58.5**	-0.4	-0.7	-1.2	-1.6	-2.2	**57.2**	-0.5	-0.9	-1.3	-1.7	-2.2	**55.7**	-0.8	-1.2	-1.7	-2.0	-2.4	**54.5**	-0.8	-1.2	-1.6	-1.9	-2.2	**49.7**	0.0	-0.1	-0.1	-0.2	-0.2
Apr	**61.7**	-0.7	-1.6	-2.5	-3.2	-3.8	**60.1**	-0.8	-1.7	-2.5	-3.2	-3.8	**57.0**	-0.7	-1.4	-2.0	-2.5	-2.9	**55.2**	-0.6	-1.2	-1.7	-2.1	-2.5	**49.7**	0.0	0.0	-0.1	-0.1	-0.2
May	**65.9**	-1.7	-3.8	-4.8	-5.6	-5.4	**63.8**	-1.9	-3.9	-5.1	-6.0	-6.6	**59.6**	-1.5	-2.9	-3.7	-4.2	-4.4	**57.2**	-1.3	-2.5	-3.1	-3.4	-3.4	**50.0**	0.0	0.0	-0.1	-0.1	0.0
Jun	**72.2**	-2.8	-4.7	-6.0	-7.0	-7.3	**70.7**	-3.4	-5.5	-6.9	-8.1	-9.0	**67.4**	-4.3	-6.1	-7.2	-8.1	-8.6	**65.3**	-4.8	-6.4	-7.4	-8.2	-8.5	**50.9**	-0.1	-0.1	0.0	0.1	0.2
Jul	**77.6**	-0.6	-0.4	-2.1	-2.1	-1.9	**76.5**	-0.7	-0.3	-2.2	-2.2	-2.0	**72.6**	-0.9	-0.5	-2.4	-2.4	-2.1	**69.8**	-0.8	-0.4	-2.0	-1.9	-1.7	**51.9**	0.1	0.2	0.4	0.6	0.9
Aug	**79.1**	0.0	0.2	-0.5	-0.4	-0.3	**78.5**	0.0	0.2	-0.6	-0.5	-0.3	**74.0**	0.0	0.2	-0.6	-0.5	-0.3	**71.1**	0.0	0.2	-0.4	-0.3	-0.2	**52.9**	0.0	0.2	0.4	0.6	0.8

Table 19-8. The 90th percentile daily 7DADM temperature values for the 1970 to 2003 model period for each month at different Tuolumne River locations, and the expected difference in °F for each of the unimpaired flow percentages between 20% and 60%. Each of the 90th percentile values which are displayed for baseline (base) indicate that daily 7DADM values were less than that temperature 90% of the time, or were greater than that temperature 10% of the time during each month and river location. Expected changes in the magnitude of 90th percentile 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

Tuolumne 90th Percentile 7DADM	Confluence (RM0)						1/4 River (RM13.2)						1/2 River (RM28.1)						3/4 River (RM38.29)						Below La Grange (RM53.5)					
	Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow					Base (°F)	Percent Unimpaired Flow				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	**80.1**	0.0	0.0	0.0	0.0	0.0	**80.2**	0.0	0.0	0.0	0.0	0.0	**77.7**	0.0	0.0	0.0	0.0	0.0	**75.8**	0.0	0.0	0.0	0.0	0.0	**55.6**	-0.3	-0.1	-0.1	-0.3	-0.3
Oct	**73.5**	0.0	0.0	-0.6	-0.6	-0.6	**72.6**	0.0	0.0	-0.3	-0.2	-0.2	**69.7**	-0.1	-0.1	-0.1	-0.1	-0.1	**66.9**	-0.2	-0.2	-0.2	-0.3	-0.2	**56.3**	-0.5	-0.5	-0.4	-0.6	-0.4
Nov	**62.8**	0.0	0.1	-0.1	-0.1	-0.1	**61.9**	0.0	0.1	-0.1	-0.1	-0.2	**60.7**	0.0	0.0	-0.1	-0.3	-0.3	**59.7**	-0.2	-0.2	-0.5	-0.5	-0.6	**56.0**	-0.3	-0.4	-0.5	-0.6	-0.1
Dec	**53.9**	0.0	0.1	0.0	0.1	0.1	**53.4**	0.0	0.1	0.1	0.2	0.2	**54.8**	0.0	0.0	0.1	0.2	0.2	**55.1**	-0.1	0.0	0.1	0.3	0.3	**54.6**	-0.3	-0.3	-0.1	0.3	0.4
Jan	**53.4**	0.0	0.0	0.2	0.1	0.2	**52.9**	0.0	0.0	0.0	0.0	0.0	**54.1**	0.0	0.1	0.2	0.2	0.2	**54.1**	0.0	0.0	0.2	0.3	0.3	**52.2**	0.0	0.1	0.4	0.6	0.8
Feb	**59.1**	-0.2	-0.5	-0.8	-1.2	-1.7	**58.5**	-0.3	-0.7	-1.1	-1.5	-2.0	**57.8**	0.1	-0.7	-1.4	-1.8	-2.3	**56.7**	0.1	-0.6	-1.2	-1.5	-1.7	**51.7**	0.0	0.0	0.0	0.1	0.2
Mar	**65.5**	-1.5	-2.5	-3.8	-4.6	-5.5	**64.6**	-1.5	-2.8	-4.1	-5.0	-5.7	**62.6**	-2.1	-3.6	-4.4	-5.3	-6.0	**60.6**	-2.0	-3.3	-4.1	-4.8	-5.3	**51.3**	-0.1	0.0	-0.1	0.0	0.0
Apr	**69.0**	-2.5	-4.5	-6.1	-7.5	-8.5	**67.4**	-2.6	-4.5	-6.2	-7.4	-8.3	**63.4**	-2.5	-4.2	-5.6	-6.5	-7.1	**60.6**	-2.1	-3.4	-4.6	-5.4	-5.8	**51.1**	0.0	-0.1	-0.1	0.0	0.0
May	**73.2**	-3.0	-5.7	-8.0	-9.6	-10.0	**71.5**	-2.8	-6.0	-8.3	-9.8	-11.0	**66.2**	-2.1	-5.2	-6.8	-7.7	-8.4	**62.8**	-1.9	-4.5	-5.7	-6.5	-6.9	**51.5**	-0.1	-0.1	0.0	0.0	0.1
Jun	**81.2**	-2.5	-3.7	-5.7	-7.7	-9.4	**81.0**	-2.9	-4.7	-7.3	-9.5	-11.5	**79.0**	-4.9	-8.5	-11.5	-13.3	-14.7	**77.0**	-6.1	-10.8	-13.1	-14.4	-15.4	**52.6**	-0.2	-0.2	-0.1	0.0	0.2
Jul	**83.8**	-0.2	-0.2	-0.3	-0.3	-0.3	**84.0**	-0.2	-0.2	-0.3	-0.4	-0.5	**81.2**	-0.3	-0.4	-0.4	-0.5	-0.5	**79.3**	-0.2	-0.2	-0.2	-0.2	-0.2	**53.4**	0.0	0.1	0.3	0.5	0.8
Aug	**83.2**	0.0	0.0	0.0	0.0	0.0	**83.3**	0.0	0.0	0.0	0.0	0.0	**80.5**	0.0	0.0	0.0	0.0	0.0	**78.6**	0.0	0.0	0.0	0.0	0.1	**54.7**	-0.2	0.0	0.0	0.0	0.2

Table 19-9. The percentage of time on the Merced River that USEPA salmon and steelhead temperature criteria (7DADM unit of measurement) are met each month under modeled baseline (base) conditions during 1970 to 2003, and the magnitude of expected percent change under modeled unimpaired flows of 20%, 30%, 40%, 50% and 60% at different river mile (RM) locations. Positive numbers under the unimpaired flows represent the magnitude of increases compared to baseline in the percentage of time that criteria are expected to be met, and negative numbers under the unimpaired flows represent the magnitude of reductions compared to baseline in the percentage of time that criteria are expected to be met. Expected changes in the amount of time that USEPA temperature criteria are met which are greater than positive 10% or less than negative 10% are highlighted green or red respectively (if applicable), and represent significant changes to salmon and steelhead temperature habitat if indicated at locations which are utilized by that life stage.

Merced River		**Confluence (RM2.5)**						**1/4 River (RM13.5)**						**1/2 River (RM27)**						**3/4 River (RM37.8)**						**Below Crocker Huffman (RM52.2)**					
Life Stage	Month / USEPA Criteria (°F)	**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**				
			20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
AM	Sep (64.4)	**3%**	0%	0%	0%	0%	-1%	**4%**	0%	0%	0%	0%	-2%	**9%**	0%	0%	0%	-1%	-4%	**14%**	0%	-1%	2%	2%	-2%	**82%**	10%	9%	8%	6%	-2%
AM	Oct (64.4)	**38%**	5%	4%	9%	9%	8%	**39%**	5%	3%	8%	8%	7%	**51%**	7%	6%	10%	9%	6%	**55%**	8%	7%	11%	9%	6%	**82%**	18%	17%	16%	14%	8%
R	Oct (55.4)	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%
R	Nov (55.4)	**17%**	2%	1%	2%	2%	1%	**14%**	2%	2%	2%	2%	1%	**13%**	3%	2%	3%	2%	1%	**9%**	1%	1%	1%	0%	-1%	**31%**	3%	1%	2%	-1%	-5%
R	Dec (55.4)	**96%**	1%	1%	2%	1%	0%	**93%**	3%	3%	3%	2%	2%	**90%**	5%	5%	5%	4%	4%	**81%**	8%	8%	8%	6%	5%	**86%**	9%	9.6%	9.97%	8%	6%
R	Jan (55.4)	**98%**	0%	0%	0%	0%	0%	**98%**	0%	0%	0%	0%	0%	**98%**	0%	0%	0%	0%	0%	**98%**	0%	0%	0%	0%	-1%	**99%**	0%	0%	0%	0%	0%
R	Feb (55.4)	**74%**	-2%	-1%	1%	2%	3%	**73%**	-2%	-1%	1%	2%	4%	**81%**	-3%	-2%	-1%	2%	2%	**74%**	-2%	-2%	0%	3%	5%	**100%**	-1%	-1%	-1%	-1%	-1%
R	Mar (55.4)	**24%**	-1%	-1%	-1%	2%	6%	**25%**	-1%	0%	0%	3%	7%	**29%**	-1%	0%	3%	7%	13%	**28%**	-1%	0%	4%	7%	14%	**97%**	-2%	-2%	-1%	0%	0%
CR	Mar (60.8)	**70%**	0%	2%	5%	11%	16%	**72%**	0%	1%	6%	12%	17%	**85%**	0%	3%	7%	9.8%	11%	**87%**	-1%	1%	6%	8%	9%	**100%**	0%	0%	0%	0%	0%
CR	Apr (60.8)	**22%**	-1%	5%	10%	25%	34%	**25%**	-1%	7%	17%	32%	43%	**39%**	-2%	17%	26%	38%	45%	**43%**	3%	21%	32%	40%	45%	**100%**	0%	0%	0%	0%	0%
CR	May (60.8)	**8%**	0%	6%	8%	15%	24%	**12%**	2%	10%	17%	30%	37%	**18%**	6%	21%	26%	37%	43%	**24%**	12%	25%	32%	40%	45%	**99%**	1%	1%	1%	1%	1%
S	Apr (57.2)	**7%**	-1%	0%	1%	5%	10%	**9%**	-1%	2%	2%	9%	14%	**12%**	0%	5%	6%	14%	19%	**16%**	0%	6%	8%	17%	22%	**95%**	2%	2%	3%	3%	3%
S	May (57.2)	**2%**	0%	0%	0%	0%	1%	**5%**	0%	0%	0%	3%	8%	**7%**	0%	1%	1%	9%	15%	**10%**	0%	6%	9%	16%	24%	**88%**	0%	4%	5%	5%	5%
S	Jun (57.2)	**0%**	0%	0%	0%	0%	0%	**2%**	0%	0%	0%	-1%	-1%	**8%**	-2%	-2%	-2%	-3%	-3%	**11%**	0%	-2%	-1%	-3%	-2%	**69%**	3%	2%	0%	0%	-1%
SR	Jun (64.4)	**16%**	2%	0%	1%	7%	13%	**21%**	3%	3%	5%	11%	15%	**26%**	3%	8%	10%	16%	21%	**28%**	6%	13%	18%	26%	31%	**97%**	3%	3%	3%	3%	3%
SR	Jul (64.4)	**5%**	0%	-1%	-1%	-1%	-3%	**16%**	0%	-2%	-2%	-5%	-7%	**20%**	0%	-3%	-3%	-7%	-9%	**23%**	0%	-3%	-4%	-6%	-9.8%	**96%**	2%	4%	3%	0%	-8%
SR	Aug (64.4)	**0%**	0%	0%	0%	0%	0%	**1%**	0%	0%	0%	0%	0%	**4%**	0%	0%	0%	-1%	-2%	**19%**	-1%	-4%	-4%	-9%	-11%	**87%**	9%	9%	5%	3%	-3%

AM = Adult Migration
R = Reproduction (Spawning, Egg Incubation, and Fry Emergence)
CR = Core Rearing
S = Smoltification
SR = Summer Rearing

Table 19-10. The average daily 7DADM temperature values for each month on the Merced River under modeled baseline (base) condition from 1970 to 2003, and the modeled difference in °F for each of the unimpaired flow percentages between 20% to 60%. Negative numbers represent the expected magnitude of reductions in 7DADM values and positive numbers represent the expected magnitude of increases in 7DADM values. Expected changes in the magnitude of 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

Merced Average 7DADM	**Confluence (RM2.5)**						**1/4 River (RM13.5)**						**1/2 River (RM27)**						**3/4 River (RM37.8)**						**Below Crocker Huffman (RM52.2)**					
	Base (°F)	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	**72.2**	0.0	0.2	-0.1	-0.1	0.0	**73.0**	-0.1	0.2	-0.2	-0.2	-0.1	**72.0**	-0.2	0.2	-0.3	-0.2	-0.1	**71.9**	-0.3	0.1	-0.5	-0.3	-0.1	**60.5**	-0.8	-0.6	-0.4	0.1	0.9
Oct	**65.9**	-0.4	-0.3	-0.7	-0.6	-0.4	**66.0**	-0.5	-0.4	-0.8	-0.7	-0.5	**65.1**	-0.7	-0.6	-0.9	-0.8	-0.4	**64.9**	-0.9	-0.8	-1.0	-0.9	-0.4	**60.1**	-1.4	-1.2	-1.2	-0.9	-0.3
Nov	**58.5**	-0.5	-0.4	-0.6	-0.5	-0.3	**58.9**	-0.6	-0.5	-0.7	-0.7	-0.4	**58.8**	-0.8	-0.7	-0.9	-0.8	-0.5	**59.6**	-0.9	-0.8	-1.1	-0.9	-0.6	**57.6**	-1.3	-1.3	-1.3	-1.1	-0.6
Dec	**51.6**	-0.2	-0.2	-0.2	-0.1	-0.1	**52.1**	-0.3	-0.3	-0.2	-0.2	-0.1	**52.4**	-0.3	-0.3	-0.3	-0.2	-0.1	**53.5**	-0.4	-0.4	-0.3	-0.2	-0.1	**52.7**	-0.5	-0.5	-0.4	-0.3	-0.2
Jan	**50.4**	0.0	0.0	0.0	0.0	0.0	**50.6**	0.1	0.1	0.1	0.1	0.0	**50.6**	0.1	0.1	0.1	0.1	0.0	**51.4**	0.1	0.1	0.1	0.2	0.1	**49.8**	0.2	0.2	0.1	0.1	-0.1
Feb	**53.7**	0.1	0.1	0.0	0.0	-0.2	**53.6**	0.2	0.1	0.0	-0.1	-0.3	**53.0**	0.2	0.1	0.1	0.0	-0.3	**53.5**	0.2	0.2	0.1	0.0	-0.3	**50.2**	0.4	0.3	0.3	0.2	-0.1
Mar	**58.6**	0.0	-0.2	-0.4	-0.8	-1.2	**58.3**	0.0	-0.2	-0.5	-0.9	-1.4	**57.1**	0.1	-0.1	-0.4	-0.7	-1.2	**57.0**	0.1	-0.1	-0.5	-0.8	-1.3	**51.9**	0.3	0.2	0.1	-0.1	-0.4
Apr	**64.0**	-0.5	-1.6	-2.2	-3.1	-3.8	**63.9**	-0.7	-2.1	-2.8	-3.7	-4.5	**61.9**	-0.6	-1.8	-2.3	-3.0	-3.7	**61.5**	-0.8	-2.0	-2.5	-3.1	-3.7	**53.1**	0.0	-0.3	-0.4	-0.7	-1.0
May	**68.2**	-2.1	-3.6	-4.3	-5.1	-5.7	**68.1**	-2.8	-4.4	-5.2	-6.2	-6.9	**65.9**	-2.7	-3.9	-4.6	-5.3	-6.0	**65.0**	-2.8	-4.0	-4.6	-5.3	-5.9	**53.8**	-0.4	-0.6	-0.8	-0.9	-1.0
Jun	**72.3**	-1.6	-2.6	-3.3	-4.0	-4.6	**72.4**	-2.3	-3.5	-4.3	-5.1	-5.8	**70.7**	-2.7	-3.8	-4.5	-5.2	-5.6	**69.9**	-3.2	-4.3	-5.0	-5.6	-6.0	**55.4**	-0.5	-0.5	-0.4	-0.3	0.0
Jul	**75.3**	-0.3	-0.1	-0.6	-0.5	-0.4	**75.7**	-0.4	-0.2	-0.8	-0.7	-0.5	**74.1**	-0.5	-0.2	-0.9	-0.8	-0.6	**73.3**	-0.5	-0.1	-0.9	-0.7	-0.4	**57.2**	-0.2	0.2	0.4	0.9	1.8
Aug	**74.6**	0.1	0.5	0.2	0.5	0.6	**75.2**	0.1	0.6	0.2	0.5	0.7	**73.8**	0.1	0.7	0.1	0.4	0.6	**73.2**	0.0	0.7	0.0	0.3	0.7	**58.8**	-0.5	-0.1	0.2	0.8	1.7

Table 19-11. The 90th percentile daily 7DADM temperature values for the 1970 to 2003 model period for each month at different Merced River locations, and the expected difference in °F for each of the unimpaired flow percentages between 20% and 60%. Each of the 90th percentile values which are displayed for baseline (base) indicate that daily 7DADM values were less than that temperature 90% of the time, or were greater than that temperature 10% of the time during each month and river location. Expected changes in the magnitude of 90th percentile 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

Merced 90th Percentile 7DADM	Confluence (RM2.52)						1/4 River (RM13.41)						1/2 River (RM27.07)						3/4 River (RM37.79)						Below Crocker Huffman (RM52.2)					
	Base (°F)	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**					**Base (°F)**	**Percent Unimpaired Flow**				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	**76.8**	0.0	0.0	0.0	0.0	0.0	**78.3**	-0.1	0.0	-0.1	0.0	0.1	**78.3**	-0.2	-0.2	-0.1	0.0	0.2	**80.2**	-0.4	-0.4	-0.3	-0.1	0.2	**67.7**	-4.0	-3.8	-3.6	-2.9	-0.5
Oct	**70.9**	-0.7	-0.4	-0.6	-0.5	0.0	**71.7**	-0.9	-0.7	-1.0	-0.8	-0.1	**70.8**	-1.6	-1.4	-1.7	-1.4	-0.3	**70.8**	-2.5	-2.2	-2.6	-2.2	-0.3	**67.4**	-6.0	-6.3	-6.2	-5.4	-2.4
Nov	**62.7**	-0.7	-0.7	-1.1	-1.1	-0.7	**63.3**	-1.1	-1.0	-1.4	-1.3	-0.8	**63.2**	-1.7	-1.7	-1.9	-1.7	-1.2	**64.4**	-2.4	-2.4	-2.7	-2.5	-2.0	**63.5**	-4.7	-4.8	-4.9	-4.4	-3.5
Dec	**54.3**	-0.4	-0.4	-0.4	-0.3	-0.2	**55.0**	-0.7	-0.7	-0.7	-0.6	-0.3	**55.4**	-1.0	-1.0	-1.0	-0.8	-0.5	**56.7**	-1.3	-1.2	-1.2	-1.0	-0.9	**56.1**	-1.6	-1.6	-1.5	-1.4	-1.1
Jan	**52.8**	0.1	0.1	0.1	0.0	0.0	**53.1**	0.0	0.0	0.1	0.0	0.0	**52.9**	0.0	0.0	0.0	0.0	-0.1	**53.7**	0.0	0.0	0.0	0.0	0.0	**52.0**	-0.3	-0.2	-0.3	-0.3	-0.4
Feb	**57.8**	0.1	0.0	0.0	-0.2	-0.4	**58.0**	0.0	0.0	0.0	-0.3	-0.5	**56.9**	0.1	0.1	0.0	-0.3	-0.5	**57.4**	0.1	0.1	0.1	-0.3	-0.4	**52.6**	0.4	0.4	0.3	0.2	0.1
Mar	**63.4**	-0.2	-0.6	-1.2	-1.7	-2.1	**63.4**	-0.1	-0.6	-1.2	-1.9	-2.3	**61.4**	0.1	-0.2	-0.9	-1.4	-1.8	**61.0**	0.2	-0.1	-0.7	-1.3	-1.6	**54.5**	0.6	0.4	0.4	0.2	0.1
Apr	**69.6**	-2.0	-3.6	-4.7	-5.4	-6.0	**70.3**	-2.8	-4.7	-5.9	-6.7	-7.3	**67.6**	-2.5	-4.1	-5.0	-5.6	-6.1	**67.2**	-2.8	-4.5	-5.2	-5.7	-6.1	**56.1**	0.0	-0.6	-0.8	-0.6	-0.7
May	**74.3**	-3.7	-4.9	-5.8	-6.7	-7.3	**75.5**	-4.8	-6.5	-7.4	-8.3	-9.1	**72.8**	-4.4	-5.9	-6.8	-7.3	-8.0	**71.7**	-4.1	-5.9	-6.7	-7.1	-7.7	**57.4**	0.0	-0.4	-0.5	-0.4	-0.5
Jun	**78.9**	-1.5	-2.3	-3.0	-3.6	-4.2	**79.9**	-1.9	-2.7	-3.7	-4.8	-5.5	**78.1**	-2.0	-3.0	-4.1	-5.3	-6.0	**77.4**	-2.0	-3.3	-5.0	-6.1	-6.6	**60.5**	-1.6	-1.4	-0.9	-0.6	-0.1
Jul	**80.6**	-0.2	-0.2	-0.6	-0.6	-0.7	**81.8**	-0.1	-0.2	-0.4	-0.4	-0.4	**80.9**	-0.4	-0.3	-0.4	-0.4	-0.2	**81.3**	-0.7	-0.7	-0.6	-0.4	0.0	**62.8**	-1.5	-1.2	-0.6	0.2	1.8
Aug	**79.8**	0.0	0.1	-0.1	-0.1	-0.1	**81.4**	0.0	0.1	-0.2	-0.2	-0.2	**80.5**	0.0	0.1	0.0	0.1	0.2	**80.7**	-0.4	-0.3	-0.2	0.0	0.6	**65.1**	-2.3	-1.6	-1.3	-0.8	1.1

Table 19-12. The percentage of time on the San Joaquin River that USEPA salmon and steelhead temperature criteria (7DADM unit of measurement) are met each month under modeled baseline (base) conditions during 1970 to 2003, and the magnitude of expected percent change under modeled unimpaired flows of 20%, 30%, 40%, 50% and 60% at different river mile (RM) locations. Positive numbers under the unimpaired flows represent the magnitude of increases compared to baseline in the percentage of time that criteria are expected to be met, and negative numbers under the unimpaired flows represent the magnitude of reductions compared to baseline in the percentage of time that criteria are expected to be met. Expected changes in the amount of time that USEPA temperature criteria are met which are greater than positive 10% or less than negative 10% are highlighted green or red respectively (if applicable), and represent significant changes to salmon and steelhead temperature habitat if indicated at locations which are utilized by that life stage.

San Joaquin River		**Vernalis (RM 69.31)**						**Above Stanislaus Confluence (RM 72.501)**						**Above Tuolumne Confluence (RM 81.401)**						**Above Merced Confluence (RM 116.001)**					
Life Stage	Month / USEPA Criteria (°F)	**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**					**Base**	**Percent Unimpaired Flow**				
			20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
AM	Sep (64.4)	**3%**	0%	0%	-1%	-1%	-1%	**1%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%
AM	Oct (64.4)	**50%**	4%	3%	10%	9%	9%	**33%**	1%	0%	4%	4%	4%	**27%**	1%	0%	2%	3%	2%	**8%**	0%	0%	0%	0%	0%
AM	Nov (64.4)	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**98%**	0%	0%	0%	0%	0%
AM	Dec (64.4)	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%
CR	Jan (60.8)	**99%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	0%	**99%**	0%	0%	0%	0%	0%
CR	Feb (60.8)	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%
CR	Mar (60.8)	**82%**	0%	2%	5%	8%	11%	**76%**	1%	3%	6%	9%	12%	**53%**	0%	0%	1%	3%	4%	**52%**	0%	0%	0%	0%	0%
S	Apr (57.2)	**5%**	0%	1%	0%	1%	3%	**3%**	0%	0%	1%	1%	2%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%
S	May (57.2)	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%
S	Jun (57.2)	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%

AM = Adult Migration
CR = Core Rearing
S = Smoltification

Table 19-13. The average daily 7DADM temperature values for each month on the San Joaquin River (SJR) under modeled baseline (base) condition from 1970 to 2003, and the modeled difference in °F for each of the unimpaired flow percentages between 20% to 60%. Negative numbers represent the expected magnitude of reductions in 7DADM values and positive numbers represent the expected magnitude of increases in 7DADM values. Expected changes in the magnitude of 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

SJR Average 7DADM	Vernalis (RM 69.31)						Above Stanislaus Confluence (RM 72.501)						Above Tuolumne Confluence (RM 81.401)						Above Merced Confluence (RM 116.001)					
	Base	Percent Unimpaired Flow					Base	Percent Unimpaired Flow					Base	Percent Unimpaired Flow					Base	Percent Unimpaired Flow				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	72.4	-0.1	0.0	-0.3	-0.2	-0.1	73.6	0.0	0.1	-0.4	-0.3	-0.3	74.1	0.0	0.1	0.0	0.0	0.1	76.5	0.0	0.0	0.0	0.0	0.0
Oct	64.7	-0.3	-0.2	-0.8	-0.8	-0.7	66.2	-0.1	0.0	-0.4	-0.3	-0.3	66.8	-0.1	-0.1	-0.3	-0.3	-0.2	68.5	0.0	0.0	0.0	0.0	0.0
Nov	56.9	-0.2	-0.1	-0.2	-0.2	-0.1	57.2	-0.1	-0.1	-0.2	-0.1	-0.1	57.9	-0.1	-0.1	-0.2	-0.2	-0.1	59.2	0.0	0.0	0.0	0.0	0.0
Dec	49.7	-0.1	-0.1	0.0	0.0	0.0	49.8	-0.1	-0.1	0.0	0.0	0.0	50.7	-0.1	-0.1	0.0	0.0	0.0	52.6	0.0	0.0	0.0	0.0	0.0
Jan	49.2	0.0	0.0	0.0	0.0	0.0	49.4	0.0	0.0	0.0	0.0	0.0	50.2	0.0	0.0	0.0	0.0	0.0	51.9	0.0	0.0	0.0	0.0	0.0
Feb	53.2	0.0	0.0	0.0	-0.1	-0.2	53.6	0.0	0.0	0.0	0.0	-0.1	54.7	0.0	0.0	0.0	0.0	0.0	55.5	0.0	0.0	0.0	0.0	0.0
Mar	58.0	0.1	-0.1	-0.2	-0.4	-0.8	58.7	0.0	-0.1	-0.3	-0.4	-0.8	60.7	0.0	0.0	-0.1	-0.2	-0.3	60.9	0.0	0.0	0.0	0.0	0.0
Apr	61.6	0.0	-0.3	-0.7	-1.1	-1.5	63.3	-0.3	-0.9	-1.4	-1.9	-2.4	66.2	0.0	-0.5	-0.8	-1.1	-1.5	66.7	0.0	0.0	0.0	0.0	0.0
May	65.7	-0.35	-1.2	-1.8	-2.4	-2.8	67.9	-0.99	-2.4	-3.2	-3.9	-4.1	71.2	-0.56	-1.3	-1.6	-2.0	-2.3	72.1	0.0	0.0	0.0	0.0	0.0
Jun	70.3	-0.1	-0.97	-1.7	-2.5	-3.0	72.7	-1.2	-2.5	-3.3	-4.1	-4.6	75.6	-0.5	-1.0	-1.3	-1.7	-2.0	77.5	0.0	0.0	0.0	0.0	0.0
Jul	75.4	-0.1	-0.2	-0.69	-0.7	-0.7	76.7	-0.3	-0.2	-0.97	-1.0	-0.9	78.4	-0.1	0.0	-0.17	-0.2	-0.1	81.7	0.0	0.0	0.00	0.0	0.0
Aug	75.6	-0.1	0.1	0.0	0.2	0.3	76.8	0.0	0.2	0.0	0.1	0.2	77.2	0.0	0.2	0.1	0.3	0.4	81.4	0.0	0.0	0.0	0.0	0.0

Table 19-14. The 90th percentile daily 7DADM temperature values for the 1970 to 2003 model period for each month at different San Joaquin River (SJR) locations, and the expected difference in °F for each of the unimpaired flow percentages between 20% and 60%. Each of the 90th percentile values which are displayed for baseline (base) indicate that daily 7DADM values were less than that temperature 90% of the time, or were greater than that temperature 10% of the time during each month and river location. Expected changes in the magnitude of 90th percentile 7DADM values greater than positive 1°F or less than negative 1°F are highlighted either red or green respectively (if applicable). The green and/or reds cells were highlighted to aid the visual review of this table and do not necessarily represent significant changes to salmon and steelhead temperature habitat.

SJR 90th Percentile 7DADM	Vernalis (RM 69.31)						Above Stanislaus Confluence (RM 72.501)						Above Tuolumne Confluence (RM 81.401)						Above Merced Confluence (RM 116.001)					
	Base	Percent Unimpaired Flow					Base	Percent Unimpaired Flow					Base	Percent Unimpaired Flow					Base	Percent Unimpaired Flow				
		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%		20%	30%	40%	50%	60%
Sep	75.9	-0.1	0.0	0.0	0.0	0.1	77.1	0.0	0.1	0.0	0.0	0.0	77.2	0.0	0.1	0.0	0.0	0.0	79.2	0.0	0.0	0.0	0.0	0.0
Oct	70.2	-0.3	-0.2	-0.9	-0.9	-0.8	71.4	0.0	0.1	-0.3	-0.3	-0.3	71.7	-0.1	0.0	-0.2	-0.2	-0.1	72.8	0.0	0.0	0.0	0.0	0.0
Nov	61.1	-0.4	-0.4	-0.7	-0.6	-0.6	61.6	-0.2	-0.2	-0.4	-0.3	-0.3	62.2	-0.3	-0.3	-0.4	-0.3	-0.2	63.1	0.0	0.0	0.0	0.0	0.0
Dec	52.3	-0.1	-0.1	0.0	0.0	0.0	52.4	-0.1	-0.1	-0.1	0.0	0.0	53.0	0.0	-0.1	0.0	0.0	0.0	54.3	0.0	0.0	0.0	0.0	0.0
Jan	51.9	0.0	0.0	0.0	0.1	0.1	52.1	0.0	0.0	0.0	0.1	0.1	52.7	0.0	0.0	0.0	0.0	0.0	53.6	0.0	0.0	0.0	0.0	0.0
Feb	56.4	0.4	0.3	0.2	0.0	-0.2	57.1	0.0	0.0	-0.1	-0.2	-0.4	58.0	0.0	0.0	0.0	0.0	0.0	57.9	0.0	0.0	0.0	0.0	0.0
Mar	61.9	0.2	-0.2	-0.8	-1.2	-1.7	63.1	-0.3	-0.6	-1.1	-1.5	-2.0	64.5	0.0	0.0	-0.2	-0.2	-0.4	64.2	0.0	0.0	0.0	0.0	0.0
Apr	65.5	-0.3	-1.4	-1.9	-2.3	-2.9	68.1	-1.4	-2.6	-3.3	-4.0	-4.5	70.3	-0.4	-1.1	-1.6	-2.1	-2.6	70.4	0.0	0.0	0.0	0.0	0.0
May	69.9	-0.9	-1.9	-2.5	-3.3	-3.9	72.7	-1.7	-3.6	-4.4	-5.4	-5.8	75.4	-0.96	-1.8	-2.1	-2.5	-2.8	75.8	0.0	0.0	0.0	0.0	0.0
Jun	75.7	-0.2	-0.8	-1.2	-1.8	-2.3	78.1	-1.3	-2.2	-2.8	-3.7	-4.4	79.4	-0.4	-0.7	-1.2	-1.6	-1.9	80.7	0.0	0.0	0.0	0.0	0.0
Jul	79.1	-0.1	-0.1	-0.2	-0.2	-0.2	80.6	-0.2	-0.2	-0.3	-0.4	-0.4	81.3	-0.1	-0.3	-0.6	-0.7	-0.7	83.5	0.0	0.0	0.0	0.0	0.0
Aug	78.8	-0.1	0.1	-0.1	-0.1	0.1	80.3	0.0	0.0	-0.1	-0.1	-0.1	80.5	0.0	0.1	0.0	-0.1	0.0	83.4	0.0	0.0	0.0	0.0	0.0

Adult Migration Evaluation Time Period, September 1 to October 31:

USEPA temperature criteria for adult salmon and steelhead migration were evaluated during the September 1 through October 31 time period. During September, adult salmon are beginning to enter the Stanislaus, Tuolumne, and Merced Rivers as they return from the ocean to spawn. During the first part of September there are few salmon found in these rivers. By the end of September, more salmon are beginning to migrate up each river, although most of the upstream migration occurs after September with peak migration typically occurring in late October and early November (CFS 2007a; CDFG 2001, 2002). The USEPA criteria used in this evaluation, and which corresponds with the adult migration life stage is less than or equal to 64.4°F using the 7-day average of the daily maximum (7DADM) unit of measurement.

Stanislaus River Adult Migration September 1 to October 31 (results in Tables 19-3, 19-4, and 19-5)

Baseline: Under modeled baseline conditions in the Stanislaus River, USEPA temperature criteria are met 10% of the time on average during September and 71% of the time on average during October at the confluence with the LSJR. Adult salmon experience temperature improvements as they swim upstream until they reach their spawning grounds (near ¾ river) where USEPA adult migration temperature criteria are met 67% of the time during September and 87% of the time during October.

20-60% Unimpaired Flows: During September, the model results indicate that compliance with USEPA adult temperature criteria (64.4°F) will increase by 12% under each unimpaired flow at the Goodwin Reservoir release location, thus achieving 100% compliance with the recommended USEPA temperature criteria for each unimpaired flow at the dam release in September. At the ½ river evaluation location, the 40%, 50%, and 60% unimpaired flows provide 14%, 13% and 11% improvements in USEPA temperature criteria compliance respectively during September. The confluence temperatures are not expected to change significantly under any of the alternative flows in September.

During October, the model results indicate that compliance with USEPA temperature criteria for adult migration (64.4°F) will increase by approximately 11%-12% under each of the unimpaired flows between the ¾ river and Goodwin evaluation locations. Additionally, model results indicate the 40%, 50%, and 60% unimpaired flows will result in increased compliance with adult migration criteria by approximately 10%-12% between the confluence and ½ river locations. However, the amount of time that reproductive criteria (55.4°F) are met in October did not increase at these locations.

Tuolumne River Adult Migration September 1 to October 31 (results in Tables 19-6, 19-7, and 19-8)

Baseline: Under modeled baseline conditions in the Tuolumne River, USEPA temperature criteria for adult migration (64.4°F) are met 2% of the time on average during September and 25% of the time on average during October at the confluence with the LSJR. Moving upstream during September, criteria are met 3%, 11%, 33%, and 100% of the time at the ¼, ½, ¾, and dam release evaluation locations respectively on average. Moving upstream during October, criteria are met 37%, 63%, 81%, and 100% of the time at the ¼, ½, ¾, and dam release evaluation locations respectively on average. Although the water released from the dam meets USEPA temperature criteria 100% of the time in September, the water temperature quickly warms, and by the time it reaches the ¾ river location USEPA compliance has already dropped to 33%. During October this warming between the dam (100% compliance) and the ¾ river (81% compliance) locations is not as dramatic.

20-60% Unimpaired Flows: Modeling indicates that the compliance with USEPA adult salmon migration criteria (64.4°F) will increase by approximately 17% under the 40% to 60% unimpaired flows at the ½ river location. No significant changes from baseline were predicted by model results on the Tuolumne River during October under any of the evaluated unimpaired flows to the amount of time that adult migration criteria (64.4°F) are met.

Merced River Adult Migration September 1 to October 31 (results in Tables 19-9, 19-10, and 19-11)

Baseline: Under modeled baseline conditions in the Merced River, USEPA adult migration temperature criteria (64.4°F) are met 3% of the time on average during September and 38% of the time on average during October at the confluence with the LSJR. Moving upstream during September, adult migration temperature criteria are met 4%, 9%, 14%, and 82% of the time at the ¼, ½, ¾, and dam evaluation locations respectively on average. Moving upstream during October, adult migration temperature criteria are met 39%, 51%, 55%, and 82% of the time at the ¼, ½, ¾, and dam evaluation locations respectively on average.

20-60% Unimpaired Flows: Modeling indicates that the 20% unimpaired flows may increase the amount of time that adult migration criteria (64.4°F) are met below Crocker Huffman Dam by approximately 10%. No other significant changes are expected in the amount of time that adult migration criteria (64.4°F) are met during September. During October, modeling results indicate that the dam release will meet adult migration criteria approximately 14% to 18% more often under the 20% to 50% unimpaired flows. The 60% unimpaired flow modeling indicates near significant improvements (8%) in the amount of time adult migration temperature criteria are met at the dam release.

Reproduction Evaluation Time Period, October 1 to March 31:

USEPA temperature criteria for salmon and steelhead reproductive life stages, which include pre-spawning, spawning, egg incubation, and fry emergence, were evaluated during the October 1 to March 31 time period. Most SJR fall-run Chinook salmon spawn between late October and early January when temperatures in the rivers are less than 55°F. Spawning generally occurs in areas where suitable habitat exists. In the Stanislaus, Tuolumne, and Merced Rivers, suitable habitat generally exists in the upper half of the anadromous portion of each river, with the majority of spawning activity typically occurring upstream of this point. Egg incubation typically occurs between November and March, lasting 40–60 days, but can vary depending on water temperatures and timing of spawning. Optimal water temperatures for egg incubation range from 41°F to 55°F (Moyle 2002; USEPA 2003). Eggs that incubate at temperatures higher than 60°F and lower than 38°F often suffer high mortality rates (Boles et al. 1988; Myrick and Cech 2001).

Newly hatched salmon (alevin) remain in the gravel for about 4–6 weeks (temperature dependent) until their yolk sacs have been absorbed (Moyle 2008). Generally, alevins suffer low mortality when consistently incubated at water temperatures between 50°F and 55°F. However, if incubated at constant temperatures between 55°F and 57.5°F, mortality has been shown to increase in excess of

50% (Boles et al. 1988). Once alevins emerge with their yolk-sac absorbed, they become fry, which tend to aggregate along stream edges, seeking cover in bushes, swirling water, and dark backgrounds (Moyle et al. 2008).

The USEPA criteria used in this evaluation, and which corresponds with the spawning, egg incubation, and fry emergence life stages is less than or equal to 55.4°F using the 7-day average of the daily maximum (7DADM) unit of measurement. For this evaluation on the Stanislaus, Tuolumne, and Merced Rivers; ½ river, ¾ river, and dam locations were used as primary indicator locations for the spawning and egg incubation life stages and all river evaluation locations were used to evaluate temperatures related to the fry life stage during this time period.

Stanislaus River Reproduction October 1 to March 31 (results in Tables 19-3, 19-4, and 19-5)

Baseline: At the ½ river, ¾ river, and dam release locations, which are representative of the spawning reach, USEPA spawning and incubation temperature criteria are met 5%, 17%, and 55% of the time respectively during October, and 36%, 45%, and 64% of the time respectively during November under baseline conditions. These sub-optimal temperature conditions during many years in in the heart of the spawning period and location may limit reproductive success on the Stanislaus River.

During December through the end of February, USEPA reproductive criteria are met greater than 90% of the time at all primary spawning locations on the Lower Stanislaus River under baseline conditions. During December, the river is warmer on average at the dam release (52.3 average 7DADM) than at the confluence (50.9 °F average 7DADM).

During March, USEPA reproductive temperature criteria (55.4°F) are met 100% of the time at the dam release under baseline conditions, but temperatures gradually warm heading downstream until USEPA criteria compliance drops to 53% of the time at ½ river.

20-60% Unimpaired Flows: The modeled flows indicate significant temperature improvements compared to baseline in the amount of time USEPA reproductive criteria are met on the Stanislaus River during the October through March time period. These temperature improvements occur in March under the 40% to 60% unimpaired flows from the confluence up to the ¾ river location. At the dam release, USEPA reproductive criteria are already met 100% of the time under baseline condition during March.

Tuolumne River Reproduction October 1 to March 31 (results in Tables 19-6, 19-7, and 19-8)

Baseline: At the ¾ river evaluation location, which is representative of much of the spawning reach, USEPA spawning and incubation temperature criteria are met less than 1% of the time during October and less than 27% of the time during November under baseline conditions. These sub-optimal temperature conditions in the heart of the spawning period and location may limit reproductive success on the Tuolumne River under baseline conditions.

During December through the end of January, USEPA reproductive temperature criteria are met greater than 93% of the time at all river locations on the Lower Tuolumne River under baseline conditions. During December, the river is warmer at the dam release (52.9 °F average 7DADM) than at the confluence (50.2 °F average 7DADM).

During February through the end of March, USEPA temperature criteria are met 100% of the time at the dam release. Temperatures gradually warm moving downstream until USEPA temperature criteria compliance drops to 72% and 54% of the time in February and March respectively at the ½ river evaluation location.

20-60% Unimpaired Flows: During this time period, significant improvements to USEPA reproductive temperature criteria compliance occur in February and March under the 30%, 40%, 50%, and 60% unimpaired flows. No significant temperature changes, relative to the reproductive criteria, are expected during October through January under any of the modeled unimpaired flows.

During February, the 60% unimpaired flow resulted in significant temperature improvements to reproductive criteria at most river evaluation locations. The 50% unimpaired flow results in significant improvements at the ½ river and ¾ river locations during February. Under the 40% unimpaired flow, temperature conditions had near significant improvements at ½ river and ¾ river during February where criteria compliance improved by 9.8% and 9.99% of the time, respectively.

During March, improvements to reproductive criteria compliance at the ¾ river evaluation location improve significantly under each of the unimpaired flows between 30-60%. At ½ river, 40-60% unimpaired flows result in significant improvements to reproductive criteria.

Merced River Reproduction October 1 to March 31 (results in Tables 19-9, 19-10, and 19-11)

Baseline: In the spawning reach (between ½ river and Crocker Huffman Dam), USEPA spawning and incubation criteria are met 0% of the time during October and between 9% and 31% of the time (depending on location) during November under baseline conditions. In November, 7DADM temperatures greater than 64°F occur 10% of the time at ¾ river. During October the frequency of warm temperatures is worse in the spawning reach with temperatures greater than 70.5°F occurring 10% of the time at ¾ river. These sub-optimal temperature conditions in the heart of the spawning period and location, likely limit reproductive success on the Merced River.

Between December and the end of February, river temperatures meet USEPA reproductive temperature criteria greater than 74% of the time at the primary spawning locations under baseline conditions.

During March, USEPA criteria are met less than 28% of the time between ¾ river and ½ river under baseline conditions.

20-60% Unimpaired Flows: The only significant temperature improvements during this time period to the USEPA reproductive temperature criteria occur during March under 60% unimpaired flow at the ½ river and ¾ river locations where compliance increases by approximately 13% of the time.

Core Juvenile Rearing Evaluation Time Period, March 1 to May 31

The USEPA salmon and steelhead core juvenile rearing temperature criterion (less than or equal to 60.8°F using the 7DADM metric) was evaluated from March 1 to May 31. During March and April fry, parr, and smolt life stages can all be found in the Stanislaus, Tuolumne, and Merced Rivers. This time period is one of relatively fast growth rates for these juvenile life stages, and is a transitional time period where fry are becoming less frequent and smolts are becoming more frequent (see CFS 2007b). By May most of the juvenile fish are classified as smolts and the fast growth rates observed in March and April have slowed as the smolts prepare for ocean entry. Juvenile salmonids can be found throughout much of the Stanislaus, Tuolumne, and Merced Rivers in March, April, and May.

Stanislaus River Core Juvenile Rearing March 1 to May 31 (results in Tables 19-3, 19-4, and 19-5)

Baseline: During March in the Stanislaus River, USEPA core juvenile rearing temperature criteria (60.8°F using the 7DADM metric) are met greater than 91% of the time at all river evaluation locations. During April this rearing criterion is met 78%, 81%, 90%, 99%, and 100% of the time at the confluence, ¼, ½, ¾, and dam release locations respectively. During May this rearing criterion is met 51%, 61%, 73%, 94%, and 100% of the time at the confluence, ¼, ½, ¾, and dam release locations respectively.

20-60% Unimpaired Flows: During March the core rearing temperature criteria was met greater than 91% of the time at all river locations under baseline conditions, therefore significant increases (>10%) in the amount of time that this criteria is met is not applicable. However, the higher unimpaired flows (40%-60%) increased USEPA core juvenile rearing temperature compliance to 100%, or close to 100%, at most river locations.

During April, modeling indicates that the 60% unimpaired flow increases core juvenile rearing temperature criteria compliance by 13% at both the confluence and ¼ river. The 50% unimpaired flow also produces significant increases in temperature compliance (11%) at the ¼ river location and near significant improvements (9.9%) at the confluence.

During May, the 50% and 60% unimpaired flows produced significant increases ranging from 11% to 22% in the amount of time that USEPA core juvenile rearing temperature criteria were met between the confluence and ½ river. Modeling also indicates that the 40% unimpaired flow increased the amount of time that USEPA juvenile rearing temperature criteria are met at the ½ river location by 9.7%.

Tuolumne River Core Juvenile Rearing March 1 to May 31 (results in Tables 19-6, 19-7, and 19-8)

Baseline: During March, the core juvenile rearing criteria are met approximately 65%, 72%, 84%, 91%, and 100% of the time at the time at the confluence, ¼, ½, ¾, and dam release locations respectively on the Tuolumne River.

During April, the core juvenile rearing criteria are met approximately 50%, 57%, 74%, 92%, and 100% of the time at the confluence, ¼, ½, ¾, and dam release locations respectively on the Tuolumne River.

During May, the core juvenile rearing criteria are met approximately 19%, 34%, 59%, 74%, and 100% of the time at the confluence, ¼, ½, ¾, and dam release locations respectively on the Tuolumne River.

20-60% Unimpaired Flows: During March through May, 30-60% unimpaired flows indicate significant temperature benefits at the confluence and ¼ river evaluation location, and 20-60% unimpaired flows indicate significant temperature benefits at the ½ and ¾ river evaluation locations. At each of the evaluation locations the higher unimpaired flows indicate greater temperature benefits when compared to the lower unimpaired flows or baseline. Modeling indicates that the largest increase in the amount of time that USEPA core juvenile rearing temperature criteria is met could occur under the 60% unimpaired alternative at the ¼ river location where criteria compliance increases by 58% during May.

Merced River Core Juvenile Rearing March 1 to May 31 (results in Tables 19-9, 19-10, and 19-11)

Baseline: During March, the core juvenile rearing criteria (60.8°F) are met approximately 70%, 72%, 85%, 87%, and 100% of the time at the confluence, ¼, ½, ¾, and dam release locations respectively on the Merced River.

During April, the core juvenile rearing criteria are met approximately 22%, 25%, 39%, 43%, and 100% of the time at the confluence, ¼, ½, ¾, and dam release locations respectively on the Merced River.

During May, the core juvenile rearing criteria are met approximately 8%, 12%, 18%, 24%, and 99% of the time at the confluence, ¼, ½, ¾, and dam release locations respectively on the Merced River.

20-60% Unimpaired Flows: Temperature modeling in March indicates that 50-60% unimpaired flows will result in significant increases in the amount of time that USEPA core juvenile rearing temperature criteria are met at the confluence and ¼ river evaluation locations. Additionally, 60% unimpaired flows will increase core juvenile rearing temperature criteria compliance at the ½ evaluation location.

During April and May, each of the 30-60% unimpaired flows result in significant increases in the amount of time that USEPA core juvenile rearing temperatures criteria are met at the ½, and ¾ river evaluation locations. At the confluence evaluation location only the 40% to 60% unimpaired flows produce significant increases in temperature criteria compliance. At each evaluation location, the higher unimpaired flows result in greater temperature benefits when compared to the lower unimpaired flows or baseline. Modeling indicates that the largest increases in the amount of time that USEPA core juvenile rearing temperature criteria are met could occur under the 60% unimpaired alternative at the ¼, ½, and ¾ river locations where criteria compliance increases by between 37% and 45% during April and May.

Smoltification Evaluation Time Period, April 1 to June 30

The primary evaluation life stages considered during the April 1 to June 30 time period are smoltification and emigration. During this time many ocean bound juvenile salmonids (steelhead and salmon) are finishing the in river growing stage and are exiting the tributaries on their way to the ocean (CFS 2006, CFS 2007b, Fish BIO 2007, Ford and Kirihara 2010). This transition from the freshwater to ocean environment (smoltification) requires significant physiological and morphological changes (Cooperman et al. 2010, Gross et al. 1988, Sheridan et al. 1983), and smolts are particularly sensitive to high temperatures during this transition (Mesick 2010a, Mesick and Marston 2007; Myrick and Cech 2001; USEPA 2003).

The USEPA temperature criteria used in this evaluation, and which corresponds with the smoltification and emigration life stages is 57.2°F or lower using the 7-day average of the daily maximum (7DADM) unit of measurement. For this evaluation on the Stanislaus, Tuolumne, and

Merced Rivers during April, May, and June; the confluence, ¼ river, and ½ river locations were used as primary indicator locations for smoltification and emigration.

Stanislaus River Smoltification April 1 to June 30 (results in Tables 19-3, 19-4, and 19-5)

Baseline: During April, May, and June Goodwin Reservoir release temperatures meet USEPA smoltification temperature criteria (57.2°F) greater than 96% of the time under baseline conditions. The river water temperature warms going downstream until the water reaches the confluence with the LSJR where USEPA criteria is met 39% of the time during April, 5% during May, and 0% during June. During May near the confluence, the 90th percentile 7DADM temperature is 66.4°F. During June near the confluence, the 90th percentile 7DADM temperature is 73.3°F under baseline conditions, which means that 10% of the time temperatures are greater than 73.3°F at the confluence in June.

20-60% Unimpaired Flows: The 50% and 60% unimpaired flows produced significant improvements in the amount of time USEPA smoltification criteria is met on the Stanislaus River during the April 1 to June 30 time period. The other alternative unimpaired flows did not produce significant improvements or reductions in temperature criteria compliance during this period.

During April on the Stanislaus River, significant improvements to smoltification temperature compliance occur under the 50% and 60% unimpaired flows at the ¾ river location by approximately 11%. Under the 60% unimpaired flow, improved temperature compliance is expected at the ¼ river evaluation location by approximately 11%.

Under 60% unimpaired flows on the Stanislaus River during May, compliance with USEPA smoltification temperature criteria increased by 17%, 22%, 22%, and 13% at the confluence, ¼ river, ½ river, and ¾ river respectively. Under 50% unimpaired flow in May, significant improvements occur at the ¼ river, ½ river, and ¾ river locations (11%, 16%, and 10% respectively). During June under the 60% unimpaired flow significant improvements (13-17%) are expected in the amount of time that smoltification criteria are met at ½ river and ¾ river locations, and under the 50% unimpaired flow significant improvements (11%) are expected at ¾ river.

Tuolumne River Smoltification April 1 to June 30 (results in Tables 19-6, 19-7, and 19-8)

Baseline: During April, May, and June La Grange Reservoir release temperatures are meeting USEPA criteria 100% of the time. Water temperature warms heading downstream until the water reaches the confluence with the LSJR where USEPA criteria is met 22% during April, 3% during May, and 0% during June under baseline conditions. The rate of warming as water flows downstream is affected by the amount of water being discharged from the reservoir.

20-60% Unimpaired Flow: Each of the evaluated unimpaired flows produced significant temperature improvements during April and May on the Tuolumne River. However during June only the 30-60% unimpaired flows indicate that significant improvements to smoltification criteria compliance will occur. Generally, the lower unimpaired flows (20% and 30%) do not result in significant improvements to smoltification temperatures in the lower reaches of the river (confluence and ¼ river locations).

On the Tuolumne River during this time period the expected temperature benefits from increased flow are greater than in any of the other time periods and/or rivers. These results indicate that the smoltification life stage within the Tuolumne River will experience far better temperature conditions under the higher unimpaired flows compared to baseline.

Modeling results indicate that the 90th percentile 7DADM temperature is reduced by up to 15.4°F (from 77.0°F to 61.6°F) under 60% unimpaired flow during June at the ¾ river location in the Tuolumne River. These reductions in high temperatures are substantial and would provide significant benefits to salmon and steelhead during June.

Merced River Smoltification April 1 to June 30 (results in Tables 19-9, 19-10, and 19-11)

Baseline: During April, May, and June at the confluence, USEPA temperature criteria are met 7%, 2%, and 0% of the time respectively under baseline conditions. At the ¾ river location USEPA temperature criteria are met 16% during April, 10% during May, and 11% during June under baseline conditions. At the dam release, USEPA temperature criteria are met 95%, 88%, and 69% during April, May, and June respectively. The dramatic decrease in USEPA temperature criteria compliance between the dam release and the ¾ river location (approximately 14.4 miles downstream) is partially a result of low releases of water. Between these same two locations, there is an approximately eleven degree difference (65.0°F at the ¾ river location versus 53.8°F at the dam release) in average daily 7DADM temperatures during May. During June a similar condition occurs where average daily 7DADM temperatures at the dam release (55.4°F) are substantially cooler than those observed at the ¾ river evaluation location (69.9°F).

20-60% Unimpaired Flow: During April in the Merced River, only the 50% and 60% unimpaired flows result in significant increases to the amount of time USEPA smoltification temperature criteria are met. Under the 60% unimpaired flow during April, significant temperature improvements occur at the confluence, ¼, ½, and ¾ river locations. Under the 50% unimpaired flow, only the ½ river and ¾ river evaluation locations improve significantly compared to baseline temperatures.

During May, the 60% unimpaired flow produced significant increases in the time of compliance with USEPA temperature criteria by 15% and 24% at the ½ river and ¾ river locations respectively. The 50% unimpaired flow produced significant benefits to smoltification temperature compliance (16%) at the ¾ river location.

During June there are not any expected temperature benefits to compliance with USEPA smoltification criteria at any Merced River locations or alternatives. However, there are substantial reductions in average daily and 90th percentile 7DADM temperatures during April, May, and June at multiple river locations.

Summer Rearing Evaluation Time Period, June 1 to August 31:

The focus of the summer rearing evaluation is on juvenile salmon and steelhead that over summer in the tributaries during the hottest time of the year and then may migrate to the ocean at a later date when water temperatures are cooler. Suitable over summering temperature habitats in the project area are usually limited to areas immediately below the impassable dams, however, during certain years there may be little or no suitable over summering temperature habitats in these tributaries. The USEPA recommended temperature criteria for the salmon and steelhead summer rearing life stage is 18°C (64.4°F) using the 7DADM metric.

Stanislaus River Summer Rearing June 1 to August 31 (results in Tables 19-3, 19-4, and 19-5)

Baseline: Modeled baseline temperatures meet USEPA summer rearing criteria 38%, 5%, and 5% of the time at the confluence during June, July, and August respectively. At ¾ river, USEPA criteria are met 81%, 43%, and 47% of the time respectively, and at the dam release USEPA criteria are met 100%, 100%, and 96% respectively during June, July, and August.

August is the month with the highest average 7DADM temperatures on the Stanislaus River. At the confluence during the modeled period, the average 7DADM temperature is 73.0 °F, and the 90th percentile temperature is 76.9°F.

20-60% Unimpaired Flow: During June, the 50% and 60% unimpaired flows produce significant improvements in the amount of time that USEPA summer rearing temperature criteria are met at the confluence, ¼ river, and ½ river evaluation locations. These unimpaired flows improve USEPA temperature compliance between 11% and 19% of the time at these locations during this time period. The other alternative unimpaired flows do not produce significant temperature benefits or impacts during June.

None of the evaluated unimpaired flows produce significant changes to the amount of time USEPA summer rearing temperature criteria are met on the Stanislaus River during July or August.

Tuolumne River Summer Rearing June 1 to August 31 (results in Tables 19-6, 19-7, and 19-8)

Baseline: Under modeled baseline conditions, June confluence temperatures meet USEPA summer rearing criteria 30% of the time, and the ¾ river evaluation location meets USEPA criteria 46% of the time. During July, modeled baseline conditions meet USEPA criteria 6% and 26% at the confluence and ¾ river evaluation locations respectively. During August, USEPA criteria are met 0% and 9% of the time at the confluence and ¾ river evaluation locations, respectively.

During June through August, the La Grange Reservoir release meets USEPA criteria 100% of the time, although the amount of water being released influences how far downstream the suitable temperatures are maintained.

During June through August, the 90th percentile 7DADM temperatures are above 81.2°F for each month at the confluence. Even at the ¾ river location the 90th percentile 7DADM temperatures are above 77.0°F during June through August.

20-60% Unimpaired Flow: During this time period modeling indicates that significant temperature benefits to summer rearing will occur during June and July, but not August. During June, each of the unimpaired flows produced significant temperature benefits at the ½ river and ¾ river evaluation locations. At the ¾ river evaluation location during June, USEPA temperature criteria compliance increases by 29%-47% under the 20% through 60% unimpaired flows. At the confluence only the 30% to 60% unimpaired flows produce significant temperature benefits which range from 11% to 36% improvement in USEPA temperature criteria compliance.

Maximum temperatures during June are dramatically reduced under most of the unimpaired flows evaluated at all river locations except at the dam release. For example, at the ½ river location during June the 90th percentile temperature is reduced 14.7°F from 79.0°F under baseline to 64.3°F under the 60% unimpaired flow.

Merced River Summer Rearing June 1 to August 31 (results in Tables 19-9, 19-10, and 19-11)

Baseline: During June through August, USEPA summer rearing temperature criteria are met at the confluence evaluation location 16%, 5%, and 0% of the time respectively. At the ¾ river evaluation location, USEPA temperature criteria are met 28%, 23%, and 19% during June, July, and August respectively. At the Crocker Huffman Reservoir release, USEPA temperature criteria are met greater than 87% of the time during this period, however, the distance in which suitable temperatures travel downstream is dependent on the amount of flow in the river.

20-60% Unimpaired Flow: Modeling during the June through August time period indicates that there are both significant increases and reductions in the amount of time that USEPA summer rearing temperature criteria are met under some of the alternative unimpaired flows.

During June, improvements to USEPA summer rearing temperature compliance occur under the 30% to 60% unimpaired flows at the ¾ river evaluation location, occur under the 40% to 60% unimpaired flows at the ½ river evaluation location, occur under the 50% and 60% unimpaired flows at the ¼ river evaluation locations, and occur under the 60% unimpaired flow at the confluence.

The reduction in USEPA summer rearing temperature criteria compliance occurs in August under the 60% unimpaired flow at the ¾ river evaluation location. Although the compliance was reduced significantly under this unimpaired flow, average daily temperatures and 90th percentile temperatures did not change substantially.

Lower San Joaquin River Temperature Analysis All Time Periods (results in Tables 19-12, 19-13, and 19-14)

On the LSJR, modeling indicates that significant temperature benefits occur during March under the 60% unimpaired flow, while other months and other unimpaired flows are not expected to produce significant benefits or impacts on optimal salmonid temperature habitat. Although there are limited benefits to optimal salmonid temperature habitat in the LSJR, there are substantial reductions in average temperatures and 90th percentile temperatures primarily during the March through June time period with higher flows providing greater reductions to these measures of temperature. These expected temperature reductions may benefit salmonids by reducing suboptimal and lethal temperature exposure. Additionally, increased flows may provide reduced travel times in the LSJR, which can reduce the time of exposure to harmful temperatures experienced by juvenile salmonids migrating in the LSJR.

Summarized Temperature Results

When considering temperature results at different river locations and different times of the year, it becomes difficult to provide an overall picture of potential temperature benefits. One way to summarize the temperature benefits of different unimpaired flows is to consider a data output we refer to as “mile-days”. This result is a measure of temperature criteria compliance in both space and time.

To calculate mile-days of temperature compliance on the Stanislaus, Tuolumne, and Merced Rivers, first 19 points are selected along each river based on output of the HEC-5Q temperature model. The rivers are then divided into 19 sections around the selected locations. The length of each section around a particular location is equal to half the distance from the preceding location plus half the distance to the following location. For example, if A, B, and C are three consecutive locations, the section around location B would have a length equal to half the distance from B to A plus half the distance from B to C. If location A is at the confluence then its corresponding section is only equal to half the distance from A to B. Similarly, if location C is at one of the dams, then the length of its corresponding section is only equal to half the distance from B to C.

7DADM temperature results are then extracted from the temperature model for each of the 19 locations. To summarize compliance with USEPA temperature criteria listed in Table 19-1, the length of each section, in miles, is multiplied by the amount of time that the corresponding location is below the temperature criterion. For example, the length of section around location B is multiplied by the number of days each month that the 7DADM temperature at location B did not exceed the specified criteria for that month. Another way to describe it is that this measurement represents the total number of river miles in compliance with the temperature criteria across all days in a given month. This is similar to the acre-days measurement that is frequently used for evaluating floodplain inundation (see USFWS 2014). Mile-days and acre-days are useful because they summarizes spatial and temporal changes while considering both frequency and magnitude. However, some of the details of exactly when and where certain changes may occur are absent in this type of statistic. Table 19-15 provides a summary of the expected temperature benefits from the proposed project for the Stanislaus, Tuolumne, and Merced Rivers combined.

Table 19-15. Summary of Mean Annual Temperature Benefits Combined for the Stanislaus, Tuolumne, and Merced Rivers from Different February through June Unimpaired Flow (UF) Percentages for all Modeled Water Years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	4,926	1,222	25%	26%	25%	30%	29%	28%
AM	Oct	64.4	5,090	3,268	64%	70%	69%	72%	72%	71%
R	Oct	55.4	5,090	343	7%	7%	6%	7%	5%	5%
R	Nov	55.4	4,926	1,430	29%	31%	29%	30%	28%	26%
R	Dec	55.4	5,090	4,677	92%	95%	95%	95%	94%	94%
R	Jan	55.4	5,090	4,972	98%	98%	98%	98%	98%	98%
R	Feb	55.4	4,762	3,806	80%	80%	81%	83%	84%	85%
R	Mar	55.4	5,090	2,574	51%	52%	55%	57%	62%	66%
CR	Mar	60.8	5,090	4,382	86%	87%	90%	93%	95%	96%
CR	Apr	60.8	4,926	3,388	69%	71%	78%	83%	87%	91%
CR	May	60.8	5,090	2,730	54%	60%	68%	73%	78%	82%
S	Apr	57.2	4,926	2,353	48%	49%	53%	56%	61%	66%
S	May	57.2	5,090	1,612	32%	34%	38%	42%	49%	54%
S	Jun	57.2	4,926	851	17%	19%	21%	23%	26%	28%
SR	Jun	64.4	4,926	2,275	46%	53%	59%	63%	68%	71%
SR	Jul	64.4	5,090	1,387	27%	28%	27%	30%	30%	29%
SR	Aug	64.4	5,090	1,007	20%	21%	19%	19%	19%	18%

AM = Adult Migration
R = Reproduction (Spawning, Egg Incubation, and Fry Emergence)
CR = Core Rearing
S = Smoltification
SR = Summer Rearing

The number of mile-days generally increases under increasing unimpaired flows, relative to baseline. Temperatures targets are already achieved much of the time under baseline during the cold weather and high flow months of December and January. The biggest improvements occur for the core rearing life stage in April and May. Under baseline, 69 and 54 percent of maximum attainment is achieved in April and May, respectively, for this critical core rearing life stage. Attainment increases to 83 and 73 percent, respectively for April and May, with 40 percent unimpaired flow. This summary statistic of temperature improvement for all year types, however, masks the benefits in critically dry years when baseline flows are lowest and benefits to temperature habitat are highest from increased flows.

Table 19-16 shows the average number of mile-days that these temperature targets are achieved in all three tributaries, combined, under baseline, and also for unimpaired flows of 20, 30, 40, 50, and 60 percent, for only critically dry years. The improvements from baseline are much bigger than the average over all years. This is important because low flow conditions in dry years currently have a negative effect on salmon survival. Under baseline in the three tributaries, 38 and 22 percent of maximum compliance is achieved in April and May, respectively for core rearing in critically dry years. Attainment of the temperature criteria increases to 64 and 46 percent, respectively for April and May, with 40 percent unimpaired flow. The temporal and spatial attainment of the temperature targets more than doubles in May. Table 19-17 also shows a similar pattern of potential improvements for dry years, and additional tables in Attachment 1 provide tributary specific summary tables.

Table 19-16. Summary of Mean Annual Temperature Benefits Combined for the Stanislaus, Tuolumne, and Merced Rivers from Different February through June Unimpaired Flow (UF) Percentages for Critically Dry Water Years

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	4,926	353	7%	10%	10%	10%	10%	9%
AM	Oct	64.4	5,090	2,627	52%	64%	63%	66%	65%	63%
R	Oct	55.4	5,090	235	5%	5%	4%	5%	3%	3%
R	Nov	55.4	4,926	1,043	21%	24%	23%	25%	22%	18%
R	Dec	55.4	5,090	4,491	88%	96%	96%	96%	96%	94%
R	Jan	55.4	5,090	5,011	98%	98%	98%	98%	98%	98%
R	Feb	55.4	4,762	3,159	66%	65%	65%	66%	68%	70%
R	Mar	55.4	5,090	827	16%	16%	20%	25%	30%	35%
CR	Mar	60.8	5,090	3,803	75%	76%	80%	85%	88%	91%
CR	Apr	60.8	4,926	1,876	38%	46%	55%	64%	70%	76%
CR	May	60.8	5,090	1,135	22%	30%	39%	46%	50%	55%
S	Apr	57.2	4,926	818	17%	20%	25%	30%	35%	40%
S	May	57.2	5,090	486	10%	12%	16%	20%	22%	26%
S	Jun	57.2	4,926	121	2%	4%	6%	7%	7%	8%
SR	Jun	64.4	4,926	645	13%	20%	26%	31%	35%	39%
SR	Jul	64.4	5,090	361	7%	9%	9%	9%	9%	9%
SR	Aug	64.4	5,090	313	6%	8%	8%	8%	7%	7%

AM = Adult Migration
R = Reproduction (Spawning, Egg Incubation, and Fry Emergence)
CR = Core Rearing
S = Smoltification
SR = Summer Rearing

Table 19-17. Summary of Mean Annual Temperature Benefits Combined for the Stanislaus, Tuolumne, and Merced Rivers from Different February through June Unimpaired Flow (UF) Percentages for Dry Water Years

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	4,926	783	16%	16%	15%	15%	14%	13%
AM	Oct	64.4	5,090	3,640	72%	71%	70%	71%	70%	70%
R	Oct	55.4	5,090	351	7%	7%	6%	7%	6%	5%
R	Nov	55.4	4,926	1,907	39%	38%	37%	36%	35%	34%
R	Dec	55.4	5,090	4,999	98%	98%	98%	98%	98%	98%
R	Jan	55.4	5,090	4,992	98%	98%	98%	98%	98%	98%
R	Feb	55.4	4,762	3,469	73%	70%	72%	73%	76%	79%
R	Mar	55.4	5,090	1,534	30%	26%	29%	36%	45%	51%
CR	Mar	60.8	5,090	4,154	82%	80%	86%	91%	93%	95%
CR	Apr	60.8	4,926	2,876	58%	62%	70%	78%	86%	89%
CR	May	60.8	5,090	2,110	41%	50%	53%	62%	70%	76%
S	Apr	57.2	4,926	1,654	34%	34%	38%	44%	50%	55%
S	May	57.2	5,090	914	18%	21%	25%	30%	34%	38%
S	Jun	57.2	4,926	247	5%	7%	8%	10%	11%	13%
SR	Jun	64.4	4,926	1,038	21%	26%	31%	37%	44%	49%
SR	Jul	64.4	5,090	513	10%	10%	10%	11%	11%	11%
SR	Aug	64.4	5,090	582	11%	11%	11%	10%	10%	10%

AM = Adult Migration
R = Reproduction (Spawning, Egg Incubation, and Fry Emergence)
CR = Core Rearing
S = Smoltification
SR = Summer Rearing

As indicated by these summary tables and the previously discussed temperature results tables, there is tremendous potential to increase suitable temperature habitat in these rivers under the proposed project. Temperature targets that are protective of salmonids are attained more frequently under 30, 40, and 50 percent unimpaired flow than under baseline for all life stages from February through June. These improvements are low estimates of the temperature improvements that can be achieved with increased flow, because flow patterns were not optimized to achieve temperature benefits. Adaptive implementation of the blocks of water represented by the various percentages of unimpaired flow can result in even larger benefits.

19.2.4 Summary and Conclusions of Temperature Evaluation

Of all of the habitat attributes for native fishes, water temperature is likely the most important one (besides having water itself), because without adequate water temperature all of the other habitat attributes (including floodplain inundation) become unusable. This temperature evaluation indicates that increasing flows during the February through June time period can provide significant temperature benefits to juvenile Fall-run Chinook salmon and steelhead. Significant temperature improvements in the Stanislaus River primarily occur under 50%-60% unimpaired flows, and in the Merced River primarily occur under 30%-60% unimpaired flows. Significant temperature improvements in the Tuolumne River occur under all alternative unimpaired flows with the least benefit occurring under 20% unimpaired flow and the most benefit occurring under 60%

unimpaired flow. Modeling results on the Tuolumne River also indicate that the 90th percentile temperature can be reduced by 15.4°F (from 77.0°F to 61.6°F) during June at the ¾ river location under 60% unimpaired flow, and that the other unimpaired flows evaluated also provide substantial reductions of the hottest temperatures at multiple locations when compared to baseline. Reductions of the hottest temperatures are possible in each month from February through June on the Tuolumne River, and would provide significant benefits to salmon and steelhead during this time period. On the Stanislaus and Merced Rivers, modeling results indicate that significant improvements in the amount of time USEPA smoltification criteria is met will only occur under the 50% or 60% unimpaired flows during April, May, and June. This is an important result because temperature impacts on the smolt life stage have been repeatedly reported as one of the limiting factors to salmonid populations in the Central Valley and SJR Basin (Kjelson et al 1982; Newman and Rice 1997; Mesick 2010a). However, there are substantial reductions to both average and 90th percentile 7DADM temperatures under all of the evaluated unimpaired flows on the Merced River during this time period that will likely benefit salmonids. Temperature improvements in the LSJR to optimal salmonid temperature habitat are expected only in March under the 60% unimpaired flow. However there are expected reductions to both average and 90th percentile 7DADM temperatures on the LSJR primarily during March through June that may be beneficial to migrating salmonids. These temperature reductions occur under all modeled unimpaired flows with the higher flows providing greater temperature improvements.

As explained by the CDFW (CDFG 2010a page 3):

> Elevated water temperatures appear to be a factor in the continued decline in adult salmon escapement abundance in the San Joaquin River Basin Watershed, either by: (1) inducing adult mortality as adults migrate into the San Joaquin River, and tributaries, to spawn (i.e., pre-spawn mortality); (2) reducing egg viability for eggs deposited in stream gravels (redds), (3) increasing stress levels and therefore reducing survival of juveniles within the tributary nursery habitats, and (4) reducing salmon smolt out-migration survival as smolts leave the nursery habitats within tributaries to migrate down the San Joaquin River to Vernalis and through the south Delta.

The results of this analysis support these conclusions by CDFW (formerly the California Department of Fish and Game [CDFG]), and the conclusions and discussions of others (Baker et al. 1995; Brandes and McLain 2001; CDFG 2005b, 2010a; Kjelson et al 1982; Kjelson and Brandes 1989; Marine and Cech 2004; Mesick 2010a; Myrick and Cech 2001; NMFS 2009a; Zeug et al. 2014) who have suggested that temperature is a limiting factor to fall-run Chinook salmon in the Bay-Delta plan area. Temperature conditions in September, October, and November are generally poor at most locations used by adult migrating and spawning salmon. Furthermore, fry emergence, rearing, smoltification, and emigration life stages are also exposed to suboptimal and even harmful temperature conditions from roughly March through June during many years. Finally, salmonids that stay in the rivers to over summer between June and September have little chance of thriving unless they find the little cold water refugia that potentially exists (depending on the year and river) directly below the dams.

Extending optimal temperature conditions both spatially (further downstream) and temporally (further into each year) will provide many juvenile salmonids with additional space and time to complete their freshwater rearing and outmigration life stages under suitable conditions. The addition of suitable temperature habitats in both space and time will reduce negative temperature effects to native fish, and will provide additional life history flexibility which can help to avoid risks that are associated with populations which lack spatial and temporal habitat diversity. Additionally, improving February through June temperature conditions will allow many anadromous salmonids to better prepare for the physiological and morphological transition they must make before entering the saltwater environment. Improving temperature conditions during this crucial and energetically expensive life stage (smoltification) (Cooperman et al. 2010, Gross et al. 1988, Sheridan et al. 1983) should increase the odds of survival of many fish, and should therefore minimize one of the key limiting factors (unsuitable water temperature) of fall-run Chinook salmon and steelhead populations in the Stanislaus, Tuolumne, and Merced Rivers (Baker et al. 1995; Brandes and McLain 2001; CDFG 2005b; Kjelson et al. 1981; Kjelson et al 1982; Marine and Cech 2004; Mesick 2010a; Myrick and Cech 2001; NMFS 2009a; Zueg et al. 2014).

Although not the focus of this project, fall spawning temperatures are less than ideal on the Stanislaus, Tuolumne, and Merced Rivers under existing baseline conditions. For example, the amount of time that USEPA spawning temperature criteria are met under modeled baseline conditions at the ¾ river locations in October and November are as follows: Stanislaus River equals 17% and 45% respectively, Tuolumne River equals 1% and 27% respectively, and Merced River equals 0% and 9% respectively. These sub-optimal temperature conditions during the core spawning period and locations are likely to dramatically limit salmon egg survival in these rivers. Reservoirs in California are often touted as being able to store cold water, and while this can be true, they also often have the unfortunate consequence of storing warm water and/or heating the stored cold water. Releases of stored warm water in the fall or early winter can delay the availability of cold water habitat needed by salmon to spawn, and this is likely impacting fall-run Chinook salmon reproductive success in the LSJR tributaries. To illustrate the delay in suitable fall-spawning temperatures, the 1960 to 2010 average daily reservoir inflow temperatures from the SJR HEC-5Q Temperature Model (CDFW 2013b) have been plotted against downstream river temperatures for each of the LSRJ tributaries (Figures 19-7, 19-8, and 19-9). The inflow temperature provides insight into temperature conditions that salmon and steelhead would have historically had access to without the current dam configurations and operations. The reservoir release temperatures and ¾ river temperatures represent the current temperature conditions that salmon and steelhead now have access to. The reservoir release temperature is a "best case" scenario, and represents temperature habitat that few fish actually experience because temperatures can warm rapidly moving downstream under many flow conditions. The approximately 1-month delay (see Figures 19-7 and 19-8) in access to optimal spawning temperatures (55.4 °F) that occurs on the Merced and Stanislaus Rivers during the fall season, creates a disconnect between migratory cues that salmon and steelhead experience in the ocean, and the currently available spawning habitat in these rivers. This delay in access to optimal spawning temperature likely affects egg viability, and potentially shortens the overall window of opportunity available to juvenile salmon and steelhead for successful development and migration prior to ocean entry.

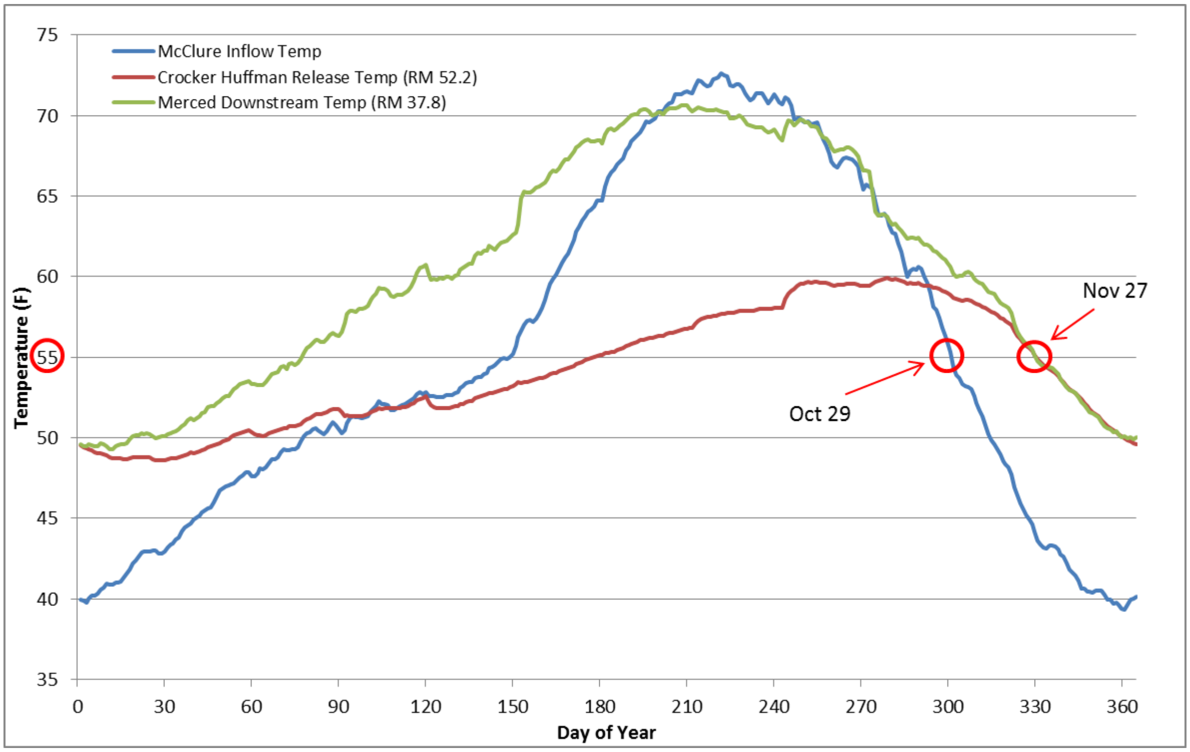

Figure 19-7. Merced River average daily temperature under baseline conditions from 1960 to 2010 at three different locations, which illustrates that both fall and spring temperature windows have been negatively altered compared to more natural conditions. There is an approximately 1-month delay from when fall-run Chinook salmon should be able to access optimal spawning temperatures (less than 55.4 °F) to when they can under current conditions.

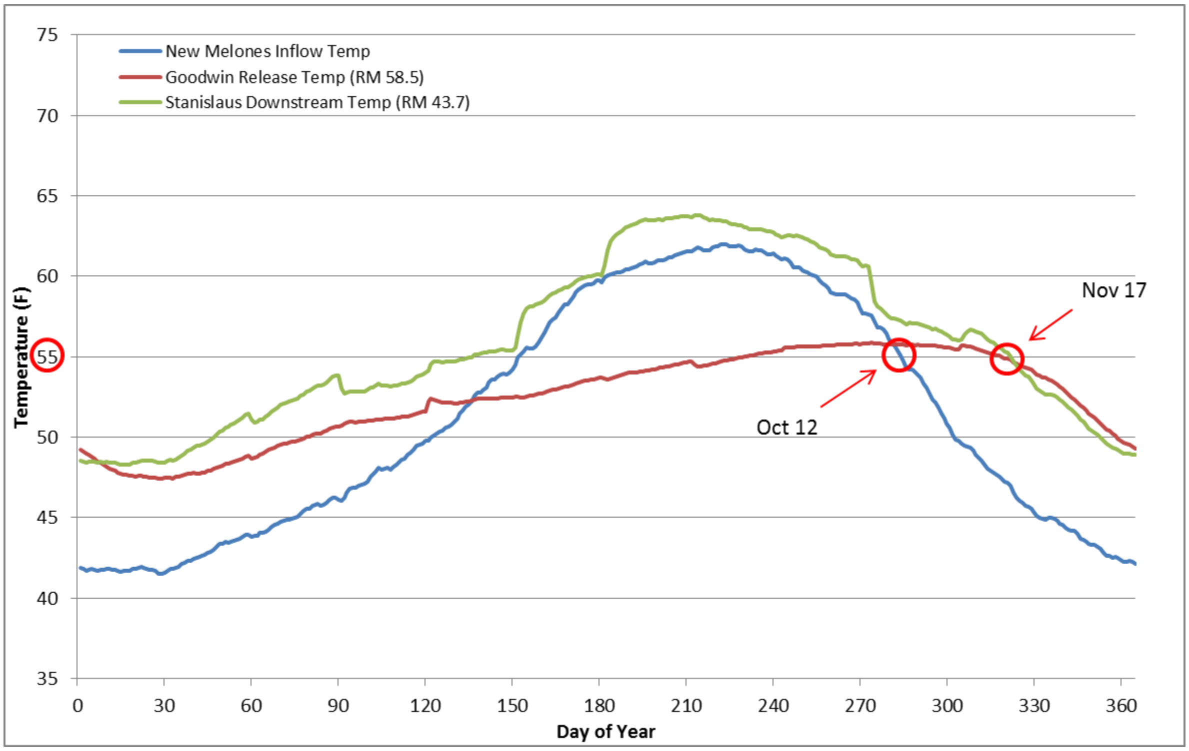

Figure 19-8. Stanislaus River average daily temperature under baseline conditions from 1960 to 2010 at three different locations. There is an approximately 1-month delay from when fall-run Chinook salmon should be able to access optimal spawning temperatures (less than 55.4 °F) to when they can under current conditions.

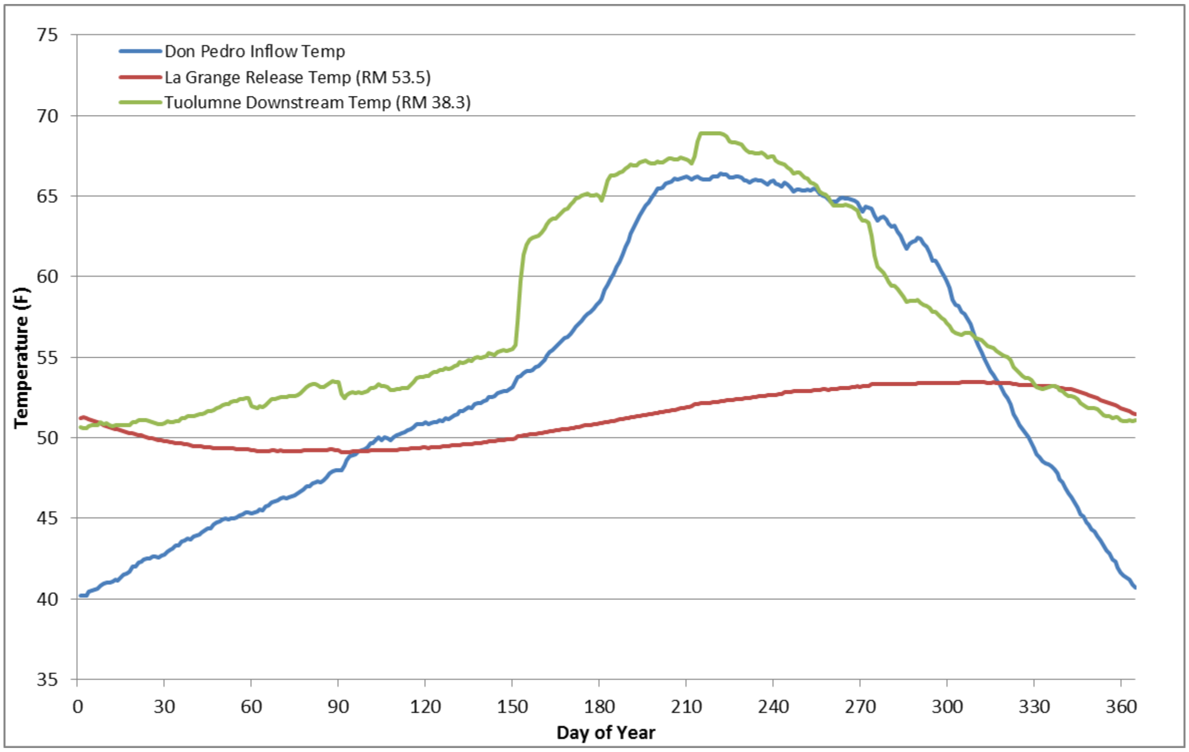

Figure 19-9. Tuolumne River average daily temperature under baseline conditions from 1960 to 2010 at three different locations, which illustrates that there is an altered temperature regime.

19.3 Floodplain Inundation

On the Stanislaus, Tuolumne, and Merced Rivers floodplain inundation is largely controlled by flows released from the reservoirs. This section describes the expected floodplain inundation benefits to juvenile salmonids and other native fishes from increased flows during the February through June time period, and provides information as to why improved floodplain inundation is important to native fish.

19.3.1 Importance of a Natural Floodplain Inundation Regime

General Introduction to Floodplain Habitat

Wetlands are celebrated world-wide for the many services they provide. They help regulate climate, store surface water, control pollution and flooding, replenish aquifers, promote nutrient cycling, protect shorelines, maintain natural communities of plants and animals, serve as critical nursery areas, and provide opportunities for education and recreation (CNRA 2010).

Within the SJR Basin and related to this Bay Delta Plan update, perhaps the most important type of wetland habitats are floodplain habitats which are adjacent to the Stanislaus, Tuolumne, Merced, and LSJ Rivers. Opperman (2012, pages 1-3) describes that:

> Floodplains are among the most biologically productive and diverse ecosystems on Earth… However, floodplains are also among the most converted and threatened ecosystems. Floodplain habitats in the

> Sacramento-San Joaquin Delta, and throughout California's Central Valley, have been greatly reduced from their historic extent and key processes that create and maintain floodplains, such as flood flows and meander migration, have been greatly altered. These widespread alterations to habitats and processes have led to declines in many species' populations in California's Central Valley and Delta.
>
> …Before the expansion of the European population in California, the Central Valley contained approximately one million hectares of floodplain habitats, including riparian forests and savannas, oxbow lakes and other water bodies, and vast expanses of tule marsh (Katibah 1984; TBI 1998). These habitats supported large, culturally important populations of fish, waterfowl, and ungulates. Diverse economic activities lead to conversion of these habitat types and it is estimated that currently less than 10% of original floodplain habitats remain (Katibah 1984; Barbour and Billings 1988)… Hydrological connectivity between rivers and floodplains has declined further because of flow regulation from large upstream multipurpose dams…

In the last 2 decades, numerous studies have demonstrated that both aquatic and riparian ecosystems benefit from dynamic connectivity between rivers and their floodplains (see Jeffres et al. 2008). Riparian species benefit from nutrients mobilized by inundation of floodplain areas (Junk et al. 1989), while riverine species benefit by having access to the floodplain for foraging, spawning, and as a refuge from high velocities found in the river during high flow events (Moyle et al. 2007). Additionally, fish yields in watersheds generally increase when water surface area in floodplains is increased (Bayley 1991 as cited in Jeffres et al. 2008; USFWS 2014).

Use of Floodplains by Salmonids

Floodplain habitats in the Central Valley have been found to have a positive effect on growth of juvenile Central Valley salmonids (Sommer et al. 2001; Sommer et al. 2005; Jeffres et al. 2008), and larger and faster growth has been associated with increased survivorship in river and to adulthood (Bond et al. 2008; Healey 1982; Fritts and Pearsons 2006; Mesick and Marston 2007a; Parker 1971; Unwin 1997; Ward et al. 1989; Zabel and Williams 2002). On the Stanislaus River, USFWS (2014) found a significant relationship between juvenile survival and floodplain acre-days, with floodplain acre-days explaining 77% of the year to year variation in juvenile survival.

The higher growth rates of juvenile Chinook salmon using Central Valley floodplains, relative to other river habitat types, have largely been attributed to the greater availability of prey within floodplain habitats (Sommer et al. 2001; Jeffres et al. 2008). For example, prey items can be orders of magnitude greater in floodplains than in adjacent rivers (Sommer et al. 2001; Grosholz and Gallo 2006). Additionally, increased growth rates may also be related to improved velocity conditions that ephemeral floodplain habitat and other side-channels can provide for juvenile salmon compared to river channels during high flow events when, in the absence of such habitat, juvenile salmon may expend excessive energy or are displaced downstream (Jeffres et al. 2008) before they are ready for downstream migration.

The timing of floodplain inundation for the protection of Central Valley Chinook salmon should generally occur from winter to mid-spring to coincide with the peak juvenile Chinook salmon outmigration period (which itself generally coincides with historic peak flows) (see State Water Board 2010). The benefits of floodplain inundation generally increase with increasing duration, with even relatively short periods of 2 weeks providing potential benefits to salmon (Jeffres et al. 2008). Benefits to salmon may also increase with increasing inter-annual frequency of flooding. Repeated pulse flows and associated increased residence times may be associated with increased productivity which would benefit salmon growth rates and potentially reduce stranding (see State Water Board 2010).

The USFWS's 2005 *Recommended Streamflow Schedules to Meet the AFRP Doubling Goal in the San Joaquin River Basin* (AFRP 2005), concludes that the declines in salmon in the SJR Basin primarily resulted from reductions in the frequency and magnitude of spring flooding in the basin from 1992-2004 compared to the baseline period of 1967-1991. In addition to floodplain being important to salmon, it may also be important to steelhead, sturgeon, splittail (as discussed below), bank swallow, western pond turtle, Fremont cottonwood and many other species important to the riverine ecosystems (CalFED 2008).

Population trend analyses for the SJR Basin suggest that salmon recruitment, which is the number of salmon that survive to the adult stage, is highly correlated with the magnitude and duration of spring flows when the fish were sub-yearling juveniles rearing in the tributaries (Mesick and Marston 2007a; Sturrock et al. 2015; USFWS 2014). The number of smolt-sized outmigrants from the Stanislaus and Tuolumne Rivers is also highly correlated with flow magnitude between February and mid-June (Mesick et al. 2007). These results suggest that fry survival in the tributaries is highest during prolonged periods of flooding and that adult recruitment is highly dependent on fry survival in the tributaries. It is likely that prolonged flooding affects fry survival by providing additional food resources, providing refuge from predators, reducing water temperatures particularly during downstream migrations in May and June, slowing the rate of disease infestation, diluting contaminants, and reducing entrainment (Mesick et al. 2007). Some of these benefits such as increased food resources and refuge from predators could be provided either by higher flows inundating existing floodplains or by constructing lower-elevation floodplains that become inundated on an annual basis with existing flows. However, other benefits such as reduced water temperatures and contaminant dilution would probably only occur during high flows (USFWS 2008).

Use of Floodplains by Splittail

The primary focus of this document is to quantify some of the benefits to salmon and steelhead from a more natural flow regime during February through June. As discussed before, native salmonids were chosen as indicator species, and providing them with more natural habitat conditions is expected to provide many other native species with more natural habitat conditions. However, when considering floodplain habitat a very important species to mention is the Sacramento splittail (*Pogonichthys macrolepidotus*), because the splittail may be one of the few native California fish that can be considered an obligate floodplain spawner (Opperman 2012), with population dynamics closely associated with annual patterns of flow and floodplain inundation (Moyle et al. 2004). Adults can spawn from late January through early July (Wang 1986), but most frequently spawning occurs during March and April (Moyle et al. 2004).

Floodplain inundation appears to be a primary factor required for strong year-classes of splittail (Sommer et al. 1997). Long-duration floodplain inundation is necessary for successful spawning, incubation, and initial rearing of larval splittail, because splittail eggs require 3 to 5 days to hatch and larval and juvenile splittail will remain on the floodplain while conditions are appropriate (Moyle et al. 2004). Long-duration flooding also allows adults time to feed on earthworms on floodplains before they spawn, and may improve spawning success by improving their condition and egg production (Moyle et al. 2004).

The splittail was historically one of the most abundant estuarine species in the Sacramento-San Joaquin estuary and supported a small hook-and-line fishery (Caywood 1974 as cited in Young and Cech 1996). It was once widely distributed in lakes and rivers throughout California's Central Valley

(Moyle et al. 2004) but disappeared from much of its native range because of loss or alteration of lowland habitats following dam construction, water diversion, and agricultural development (Young and Cech 1996). The species is now largely restricted to the Sacramento-San Joaquin estuary except during upstream spawning migrations (Moyle et al. 2004).

Food Production of Floodplains

Inundated floodplains produce phytoplankton and other algae (Ahearn et al. 2006), which are sources of biologically available carbon that are particularly important to downstream food-limited ecosystems such as the Sacramento–San Joaquin Delta (Sobczak et al. 2002; Opperman 2012). The flow of energy from algae to zooplankton and other invertebrates influences floodplain resources for native fish. In the Yolo Bypass drift macroinvertebrates, including chironomids and terrestrial invertebrates, were the primary food resource for juvenile Chinook salmon (Sommer et al. 2001), and were positively correlated with flow (Opperman 2012). In the Yolo Bypass, these organisms attain high densities soon after inundation, providing a food source to fish that is available before food web productivity develops, which requires longer inundation events (Sommer et al. 2004).

Quality of Floodplain Habitat

While it is important to have a natural flow regime which inundates floodplains with proper timing, frequency, magnitude, and duration, it is also important to note that the quality of floodplain habitat is important. A floodplain with sufficient heterogeneity and habitat complexity will facilitate desired ecosystem responses (i.e. diversity of the food web) that may be utilized by salmonids (Bellmore et al. 2013). However, as an example, flooding a parking lot with sufficient timing, frequency, magnitude, and duration necessary for fish will not produce the kinds of ecosystem responses that are desired. In addition, areas with engineered and managed water control structures can have comparatively higher rates of stranding fish (Sommer et al. 2005). Further, floodplains that are too shallow or that lack vegetative cover may also make salmon more susceptible to avian predation (Gawlik 2002). Therefore, it is important that restored floodplains, or multi-benefit projects (i.e. agriculture/floodplain projects) are managed and designed in a manner that provides cost effective results and do not have unintended ecological consequences.

Summary

The importance of floodplain habitats to native fish and wildlife in the Central Valley has been well documented, but floodplains and the frequency which the remaining ones are inundated, have been greatly reduced from their historic extent. Properly managed floodplains can have widespread benefits at multiple levels ranging from individual organisms to ecosystems (Junk et al. 1989; Moyle et al. 2007). The following analysis will evaluate how increasing river flow during February through June will improve floodplain inundation in the Stanislaus, Tuolumne, Merced, and LSJ Rivers.

19.3.2 Methods of Floodplain Inundation Evaluation

Modeled flow outputs were used to predict the frequency and magnitude of monthly flow and floodplain events during the February through June time period in the Stanislaus, Tuolumne, Merced, and LSJ Rivers under baseline and several unimpaired flow percentages. Average monthly flow for each month (February through June) during 1922 to 2003 (n=82 years for each month) was used to estimate the expected frequency and magnitude of floodplain inundation. The February through June time period represents the time period that this project could potentially benefit rearing juvenile salmonids by increasing floodplain habitat. The following methods sections provide additional details regarding the flow modeling, evaluation criteria, and floodplain versus flow relationships used for each water body evaluated.

Methods: Computer Modeling Used in Floodplain Evaluation

The State Water Resource Control Board (State Water Board) developed the WSE model to simulate the baseline and LSJR alternatives for water years 1922-2003 and to determine the effects on reservoir operations, water supply diversions, and river flow for each of the eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers) and flow and salinity at Vernalis on the SJR. The WSE model was used for this floodplain inundation analysis by estimating monthly average flows for the 82-year period under different unimpaired flow scenarios. The scientific basis for the WSE model is described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and the detailed methods and results for the LSJR alternatives are presented in Appendix F.1, *Hydrologic and Water Quality Modeling*.

Methods: Floodplain Evaluation Criteria

The frequency during the 82-year modeling period (1922 to 2003) that different monthly average flows, and the related floodplain acreages, are achieved was compared between baseline and unimpaired flows of 20%, 30%, 40%, 50%, and 60%. A 10% change in the frequency of floodplain flows, in combination with professional judgment, is used to determine a significant benefit or impact. Ten percent was selected because it accounts for a reasonable range of potential error associated with the assumptions used in the various analytical and modeling techniques. In addition, lacking quantitative relationships between a given change in environmental conditions and relevant population metrics (e.g., survival or abundance), a 10% change was considered sufficient to potentially result in beneficial or adverse effects to sensitive species at the population level.

Methods: Floodplain Versus Flow Relationships

Stanislaus River

This section presents a summary of the methods used by USFWS to develop floodplain versus flow relationships on the Stanislaus River. The USFWS (2011, 2012, and 2013) documentation should be reviewed for a complete description of the methods used.

The USFWS (2011, 2012, and 2013) developed two-dimensional hydraulic models to quantify the relationship between floodplain area and flow for the following four reaches of the Stanislaus River: 1) mouth of Stanislaus River to Ripon, 2) Ripon to Jacob Meyers, 3) Jacob Meyers to Orange Blossom, and 4) Orange Blossom to Knight's Ferry (Figure 19-10). Light Detection and Ranging (LIDAR) and Sound Navigation and Ranging (SONAR) data collected for the Stanislaus River instream flow study was used as the topographic data source for the hydraulic model.

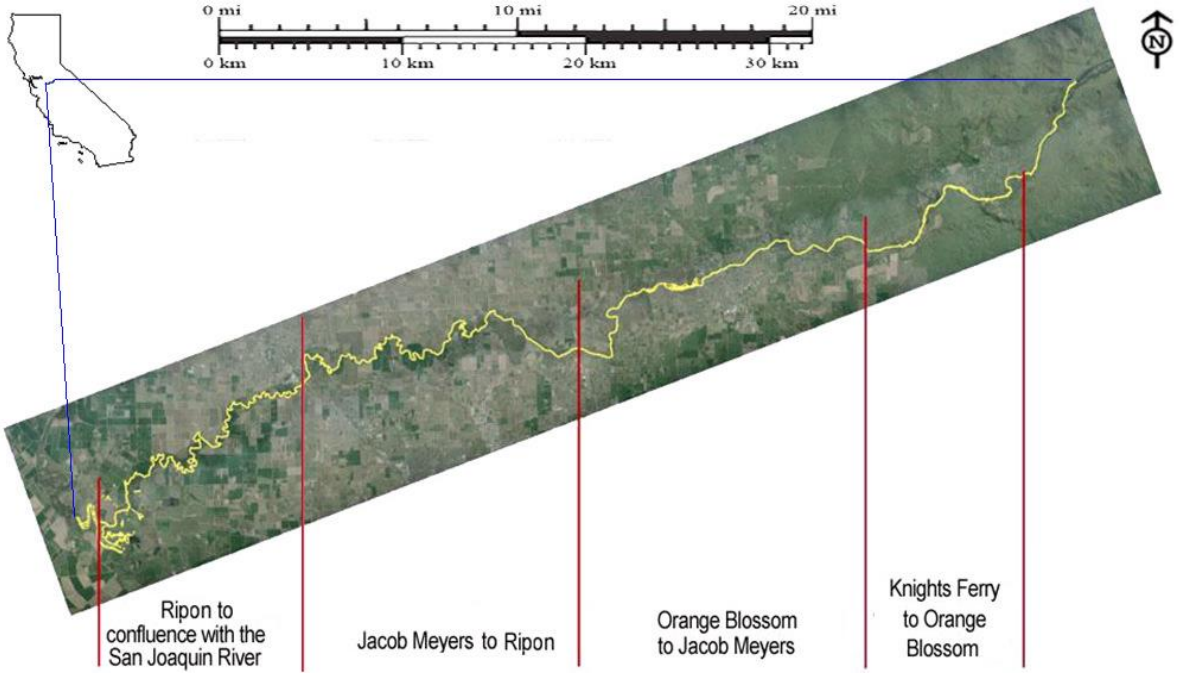

Figure 19-10. Reaches for Stanislaus River floodplain area versus flow modeling. This figure was developed by the USFWS (2013).

The calibrated model was then used for hydraulic simulations at flows ranging from 250 to 5,000 cfs. The model output was then processed in SMS to compute the total wetted area at each flow. The resulting total wetted area versus flow graph was then examined to determine the flow at which floodplain inundation begins, as shown by an inflection point in the graph. The total wetted area at higher flows was then subtracted from the total wetted area at which floodplain inundation begins to determine the inundated floodplain area at each flow and for each reach.

USFWS (2011, 2012, 2013) found that in the Stanislaus River confluence (with the LSJR) to Ripon reach floodplain inundation starts at 1,500 cfs, in the Ripon to Jacob Meyers reach floodplain inundation starts at 1,250 cfs, in the Jacob Meyers to Orange Blossom reach floodplain inundation starts at 1,000 cfs, and in the Orange Blossom to Knight's Ferry reaches floodplain inundation starts at 1,250 cfs. They were not able to develop hydraulic models for the Goodwin Dam to Knight's Ferry Bridge reach, because SONAR data is not available for that reach.

The current State Water Board floodplain analysis uses USFWS' Stanislaus River floodplain area versus flow relationship (Table 19-18) to analyze the potential effects that a range of unpaired flows (20%, 30%, 40%, 50%, and 60%) could have on available floodplain habitat used by fall-run Chinook salmon and steelhead.

Table 19-18. Floodplain versus flow relationship for the entire modeled portion (Knight Ferry (RM 54.5) to the confluence (RM 0)) of the Stanislaus River (from USFWS 2013b and personal communication Mark Gard 2013)

Flow (cfs)	FP Acres
250	0
500	0
750	0
1000	0
1250	19
1500	46
1750	111
2000	161
2250	207
2500	250
2750	289
3000	326
3250	362
3500	399
3750	427
4000	455
4250	500
4500	536
4750	572
5000	609

Tuolumne River

This section presents a summary of the methods used by USFWS (2008) to develop floodplain versus flow relationships on the Tuolumne River. The USFWS documentation should be reviewed for a complete description of the methods used.

The USFWS (2008) used direct observation, aerial photography, and GIS techniques to map the wetted surface area for a range of flows between 100 cfs and about 8,500 cfs in order identify potential floodplain habitat on the Tuolumne River. The lower Tuolumne River was chosen for this study, as appropriate GIS data were available for the reach between La Grange Dam at RM 52 and just upstream of Santa Fe Bridge at RM 21.5 near the town of Empire. The data used for this analysis were originally developed as part of the FERC relicensing proceedings for the Don Pedro Project (Project No. 2299). From the information available, USFWS developed a wetted surface area versus flow relationship for the study site (Figure 19-11).

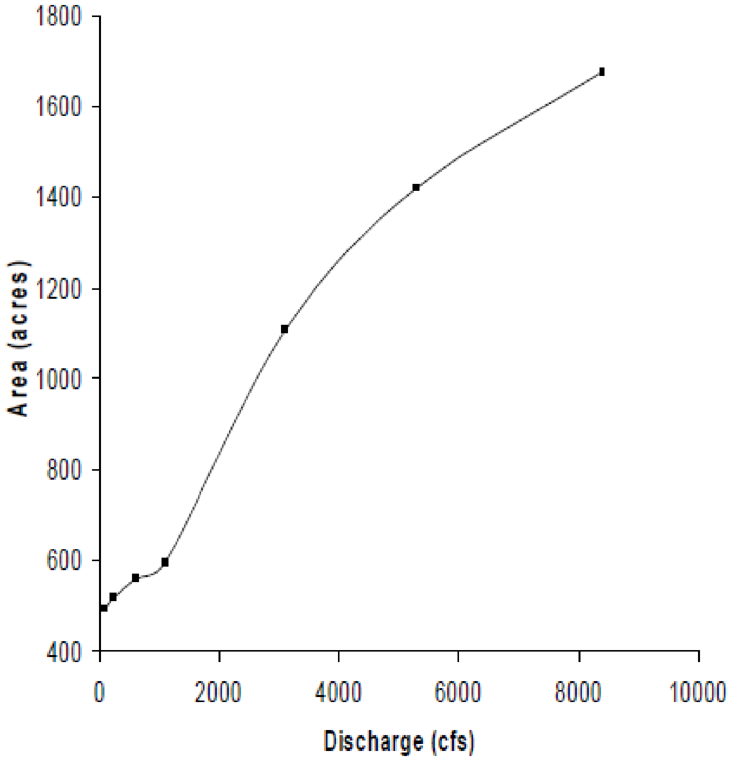

Figure 19-11. Lower Tuolumne River wetted surface area as a function of discharge from RM 52 to RM 21.5. This figure and relationship were developed by USFWS (2008).

The wetted surface area versus discharge relationship indicates a primary inflection around 1,100 cfs which suggests that this is the minimum point where flows may begin to inundate "overbank" areas, or extend out of the channel and into the floodplain. Using the wetted surface area versus discharge relationship and the overbank flow of 1,100 cfs, USFWS developed an overbank (floodplain) area versus discharge relationship by subtracting the in-channel area from the total wetted area for each flow value above initial inundation (Figure 19-12).

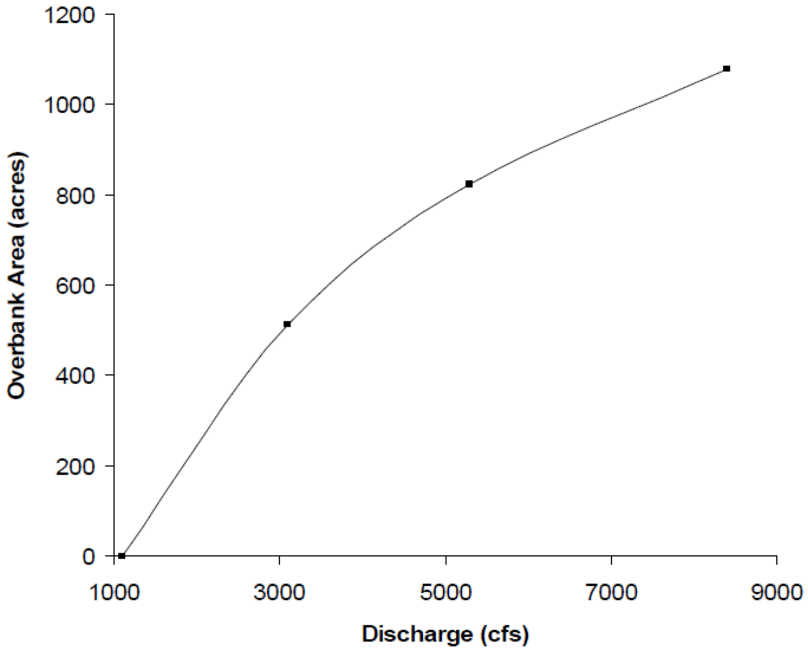

Figure 19-12. Lower Tuolumne River overbank (floodplain) inundated area as a function of discharge from RM 52 to RM 21.5. This relationship was developed by USFWS (2008).

We used this Tuolumne River floodplain area versus flow relationship (Figure 19-12 and Table 19-19) to analyze the potential effects that a range of unpaired flows (20%, 30%, 40%, 50%, and 60%) could have on available floodplain habitat used by fall-run Chinook salmon and steelhead.

Table 19-19. Lower Tuolumne River overbank (floodplain) inundated area as a function of discharge from RM 52 to RM 21.5. These table values were developed by USFWS (2008).

Flow (cfs)	FP Acres
1100	0
3100	513
5300	823
8400	1079

To provide further information for this State Water Board evaluation, additional floodplain values were estimated by fitting a line to the data in Table 19-19. The resulting equation is: $y=530.68\ln(x) - 3728.5$ ($R^2 = 0.9986$), where y equals floodplain acreage and x equals flow in cubic feet per second (cfs).

Merced River

On the Merced River, floodplain versus flow relationships have not been developed to the level of detail of those developed on the Stanislaus, Tuolumne, and LSJR. Therefore, water surface widths (cross sections) from the HEC-5Q temperature model were used at roughly 1-mile increments along the Merced River for a range of flow values. These cross sections were used between Crocker Huffman Dam (RM 52.2) and Santa Fe Road (RM 27) to develop a reach wide water surface area versus flow relationship to estimate floodplain acreage. The relationship for this portion of the river indicated that floodplain inundation begins between 500 and 1000 cfs. We determined that a floodplain inundation threshold of 1000 cfs on the Merced River above RM 27 was appropriate for this evaluation based on the above information, and on the inundation thresholds determined by USFWS on the Stanislaus (1000 cfs) and Tuolumne (1100 cfs) Rivers. Once the inundation threshold was determined, the in-channel water surface area was subtracted from the total water surface area to determine the out-of-channel surface area (floodplain area). The resulting floodplain versus flow relationship used is: $y = 342.69\ln(x) - 2380.9$ ($R^2 = 0.9952$) (Table 19-20), where y equals floodplain acreage and x equals flow in cfs.

Table 19-20. Merced River floodplain area versus flow from Crocker Huffman Dam (RM 52.2) to Santa Fe Road (RM 27).

Flow (cfs)	Floodplain Acreage
1000	0
1250	63
1500	125
2000	224
3000	363
4000	461
5000	538

Lower San Joaquin River

cbec, inc. (2010) utilized a 1D hydraulic model for the SJR, between the Merced River confluence and the Mossdale Bridge, to characterize the relationship between floodplain inundation and flow (Table 19-21 (data from cbec's Table 5)). Inundation mapping was performed by running a range of flows through the model in increments of 1,000 cfs from 1,000 cfs up to 25,000 cfs. The inundation mapping data was delineated into four reaches: Reach 1 is from Newman (Hills Ferry Road just downstream from the Merced River) to E Las Palmas Avenue (19 miles), Reach 2 is from E Las Palmas Avenue to the Tuolumne River (14 miles), Reach 3 is from the Tuolumne River to the Stanislaus River (10 miles), and reach 4 is from the Stanislaus River to Mossdale (Interstate 5) Bridge (17 miles). Flow versus floodplain inundation relationships developed by cbec, were used in this State Water Board analysis to evaluate effect of different unimpaired flows on floodplain in the LSJR.

Table 19-21. Inundated floodplain acreage in San Joaquin River between Mossdale (Interstate-5 Bridge (RM 56.2) and the confluence with the Stanislaus River (RM 72.5). This information is from Table 5 in cbec 2010, but acres are rounded to the nearest whole number.

Flow (cfs) at Vernalis	Reach 1 and 2 combined: Merced to Tuolumne River (33 miles)	Reach 3: Tuolumne to Stanislaus River (10 miles)	Reach 4: Stanislaus to Mossdale (17 miles)
1000	67	8	62
2000	39	23	75
3000	129	29	83
4000	287	40	91
5000	753	100	99
6000	1286	213	108
7000	2020	286	125
8000	2767	400	231
9000	3630	574	353
10000	4480	780	500
15000	6707	1865	908

19.3.3 Results of Floodplain Inundation Evaluation

The results of the current floodplain analysis indicate that improvements (compared to baseline) to the frequency of floodplain inundation can be achieved by implementing the 20%, 30%, 40%, 50%, or 60% unimpaired flows. The improvements to the frequency of floodplain inundation events primarily occur during April, May, and June, although the higher unimpaired flows (40-60%) provide some benefit in February and March. During April through June, most of the unimpaired flows evaluated provide some benefit compared to baseline, with the lower unimpaired flow providing less benefit and the higher unimpaired flows providing greater benefit (Tables 19-22 through 19-27).

Table 19-22. Percentage of years under baseline (base) conditions with average monthly Stanislaus River flows at Goodwin Dam greater than the specified flow, and the expected percent change under each of the unimpaired flows between 20% and 60%. Corresponding floodplain acreages are from Knights Ferry (RM 54.5) to the confluence with the SJR (RM 0). The gray shading indicates flows which are below the floodplain inundation threshold. Changes to frequency of occurrence which are greater than positive 10% are highlighted green, and changes to frequency of occurrence which are less than negative 10% are highlighted red (if applicable).

Stanislaus River		February						March						April						May						June					
Flow (cfs)	Floodplain Acreage	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%
100	0	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%
200	0	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	-1%	0%	0%	0%	0%
250	0	**49%**	5%	13%	23%	32%	37%	**61%**	2%	21%	28%	34%	38%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**85%**	6%	9%	9%	11%	10%
500	0	**21%**	1%	12%	23%	32%	40%	**48%**	-7%	0%	10%	28%	37%	**98%**	0%	1%	1%	2%	2%	**89%**	4%	7%	9%	10%	10%	**44%**	1%	11%	23%	30%	37%
750	0	**12%**	0%	10%	15%	27%	34%	**37%**	-2%	0%	0%	10%	24%	**84%**	2%	6%	7%	13%	12%	**73%**	-1%	10%	17%	18%	24%	**41%**	-6%	5%	11%	21%	29%
1000	Initiates	**10%**	1%	2%	12%	15%	26%	**30%**	2%	4%	2%	2%	12%	**60%**	-1%	5%	13%	23%	28%	**59%**	9%	17%	21%	28%	30%	**37%**	-4%	1%	6%	18%	26%
1250	19	**10%**	0%	1%	4%	12%	13%	**29%**	4%	1%	0%	0%	4%	**57%**	0%	1%	7%	13%	24%	**59%**	2%	12%	13%	18%	28%	**7%**	-4%	5%	16%	29%	44%
1500	46	**7%**	2%	4%	2%	9.8%	13%	**29%**	4%	1%	-4%	-4%	0%	**43%**	-9%	-9.8%	-1%	12%	22%	**40%**	-7%	11%	17%	27%	35%	**5%**	-2%	2%	9%	29%	34%
2000	161	**7%**	1%	1%	1%	2%	5%	**4%**	0%	-1%	0%	1%	6%	**0%**	0%	0%	4%	15%	34%	**11%**	-2%	5%	20%	40%	51%	**1%**	0%	4%	4%	12%	26%
3000	326	**4%**	0%	0%	1%	1%	1%	**2%**	0%	0%	-1%	-1%	1%	**0%**	0%	0%	0%	1%	2%	**0%**	0%	1%	7%	15%	40%	**1%**	0%	0%	0%	4%	6%
4000	455	**1%**	0%	0%	0%	1%	1%	**1%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	1%	5%	11%	**1%**	0%	0%	0%	0%	4%
5000	609	**0%**	0%	0%	0%	0%	1%	**1%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	1%	4%	**0%**	0%	0%	0%	1%	1%

Table 19-23. Percentage of years under baseline (base) conditions with average monthly Tuolumne River flows at La Grange Dam greater than the specified flow, and the expected percent change under each of the unimpaired flows between 20% and 60%. Corresponding floodplain acreages are from La Grange Dam (RM 52) to just upstream of Santa Fe Bridge (RM 21.5). The gray shading indicates flows which are below the floodplain inundation threshold. Changes to frequency of occurrence which are greater than positive 10% are highlighted green, and changes to frequency of occurrence which are less than negative 10% are highlighted red (if applicable).

Tuolumne River		February						March						April						May						June					
Flow (cfs)	Floodplain Acreage	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%
75	0	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**78%**	16%	18%	18%	21%	21%
150	0	**93%**	2%	6%	6%	6%	6%	**91%**	7%	9%	9%	9%	9%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**49%**	38%	43%	46%	48%	50%
300	0	**46%**	9%	16%	23%	34%	41%	**67%**	5%	23%	26%	30%	32%	**94%**	2%	5%	6%	6%	6%	**95%**	2%	5%	5%	5%	5%	**28%**	46%	59%	63%	67%	68%
500	0	**44%**	4%	10%	10%	18%	28%	**56%**	4%	6%	24%	30%	37%	**70%**	12%	22%	28%	30%	30%	**66%**	22%	32%	34%	34%	34%	**27%**	40%	49%	60%	63%	65%
1000	0	**38%**	0%	0%	-2%	1%	11%	**55%**	-2%	-2%	-10%	0%	15%	**52%**	0%	13%	27%	40%	45%	**51%**	9%	32%	45%	46%	48%	**24%**	18%	37%	48%	51%	59%
1100	Initiates	**38%**	-1%	-2%	-5%	0%	6%	**55%**	-4%	-2%	-9.8%	-7%	7%	**44%**	-2%	15%	33%	44%	54%	**35%**	15%	45%	57%	62%	63%	**24%**	13%	35%	48%	50%	55%
1250	56	**37%**	-1%	-4%	-5%	-1%	2%	**51%**	-4%	-4%	-9.8%	-9.8%	-1%	**41%**	-1%	11%	29%	39%	50%	**26%**	22%	52%	60%	72%	72%	**22%**	7%	34%	45%	50%	54%
1500	152	**34%**	-1%	-5%	-9%	-2%	1.2%	**46%**	-4%	-7%	-7%	-9.8%	-4%	**37%**	-1%	4%	20%	38%	45%	**20%**	13%	44%	63%	70%	78%	**22%**	0%	24%	38%	50%	50%
2000	305	**28%**	0%	-4%	-7%	-5%	4%	**40%**	-2%	-4%	-9%	-9%	-5%	**33%**	-1%	-1%	2%	18%	37%	**17%**	1%	29%	51%	65%	68%	**21%**	-1%	7%	23%	39%	48%
3000	520	**22%**	-4%	-5%	-5%	-6%	-4%	**34%**	0%	-5%	-11%	-12%	-9.8%	**21%**	0%	0%	-2%	-4%	5%	**13%**	1%	2%	18%	45%	59%	**15%**	0%	0%	2%	26%	34%
4000	673	**11%**	0%	-1%	-2%	-1%	-1%	**16%**	-2%	-2%	-2%	-5%	-5%	**11%**	0%	-1%	0%	-1%	-2%	**11%**	1%	1%	0%	13%	38%	**10%**	0%	0%	0%	6%	22%
5000	791	**10%**	0%	-1%	-2%	-2%	-1%	**7%**	0%	0%	0%	-1%	0%	**5%**	0%	0%	-1%	-1%	-1%	**7%**	1%	0%	0%	4%	15%	**5%**	0%	0%	1%	2%	9%

Table 19-24. Percentage of years under baseline (base) conditions with average monthly Merced River flows at Crocker Huffman Dam greater than the specified flow, and the expected percent change under each of the unimpaired flows between 20% and 60%. Corresponding floodplain acreages are from Crocker Huffman Dam (RM 52.2) to Santa Fe Road (RM 27). The gray shading indicates flows which are below the floodplain inundation threshold. Changes to frequency of occurrence which are greater than positive 10% are highlighted green, and changes to frequency of occurrence which are less than negative 10% are highlighted red (if applicable).

Merced River		February						March						April						May						June					
Flow (cfs)	Floodplain Acreage	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%
100	0	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**98%**	2%	2%	2%	2%	2%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%
200	0	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**65%**	23%	30%	33%	35%	35%	**70%**	29%	29%	30%	30%	30%	**24%**	49%	65%	71%	72%	74%
300	0	**40%**	1%	6%	5%	11%	23%	**90%**	4%	2%	6%	9%	9%	**56%**	13%	35%	40%	41%	44%	**62%**	33%	37%	37%	37%	38%	**23%**	33%	51%	60%	68%	71%
400	0	**38%**	0%	2%	0%	9%	12%	**26%**	4%	11%	24%	49%	59%	**50%**	4%	33%	44%	48%	48%	**50%**	37%	46%	49%	49%	49%	**23%**	28%	43%	52%	60%	66%
500	0	**34%**	-1%	0%	4%	6%	11%	**24%**	1%	5%	12%	30%	52%	**46%**	-12%	22%	43%	49%	51%	**43%**	29%	46%	55%	55%	56%	**23%**	16%	34%	48%	52%	57%
750	0	**30%**	0%	-1%	2%	4%	7%	**20%**	0%	1%	4%	7%	23%	**20%**	-2%	15%	38%	56%	70%	**23%**	23%	51%	60%	73%	74%	**22%**	4%	21%	30%	41%	49%
1000	Initiates	**29%**	-1%	-4%	-1%	0%	5%	**15%**	0%	0%	0%	4%	9%	**5%**	0%	11%	20%	43%	66%	**22%**	11%	37%	52%	61%	70%	**22%**	0%	6%	17%	29%	40%
1250	63	**26%**	0%	-1%	-4%	-2%	4%	**12%**	0%	0%	0%	1%	4%	**4%**	0%	2%	5%	26%	40%	**16%**	4%	26%	40%	59%	66%	**20%**	1%	2%	9%	21%	32%
1500	125	**17%**	1%	2%	-1%	-2%	4%	**10%**	0%	0%	0%	-1%	1%	**2%**	0%	0%	2%	9%	29%	**15%**	0%	15%	28%	49%	60%	**18%**	0%	-1%	1%	11%	22%
2000	224	**11%**	1%	1%	-2%	-1%	-1%	**6%**	0%	0%	0%	0%	0%	**1%**	0%	0%	0%	1%	6%	**12%**	0%	2%	6%	27%	44%	**16%**	1%	-2%	-2%	2%	9%
3000	363	**6%**	1%	0%	-4%	-4%	-4%	**4%**	1%	1%	1%	1%	1%	**1%**	0%	0%	0%	0%	0%	**5%**	0%	1%	1%	2%	12%	**10%**	-1%	-2%	-1%	-2%	0%
4000	461	**4%**	0%	-1%	-1%	-2%	-2%	**1%**	1%	1%	1%	1%	1%	**1%**	0%	0%	0%	0%	0%	**1%**	0%	0%	0%	0%	1%	**6%**	0%	0%	0%	-1%	-5%
5000	538	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**1%**	0%	0%	0%	0%	0%	**1%**	0%	0%	0%	0%	0%

Table 19-25. Percentage of years under baseline (base) conditions with average monthly San Joaquin River flows (above the Tuolumne River confluence) greater than the specified flow, and the expected percent change under each of the unimpaired flows between 20% and 60%. Corresponding floodplain acreages are from Newman (Hills Ferry Road just downstream from the Merced River) to the Tuolumne River (33 miles). Changes to frequency of occurrence which are greater than positive 10% are highlighted green, and changes to frequency of occurrence which are less than negative 10% are highlighted red (if applicable).

San Joaquin River Reach 1 and 2		February						March						April						May						June					
Flow (cfs)	Floodplain Acreage	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%
1000	67	**73%**	0%	0%	-1%	0%	4%	**55%**	0%	1%	4%	7%	12%	**50%**	-5%	4%	16%	27%	34%	**35%**	18%	34%	46%	52%	55%	**22%**	2%	17%	28%	40%	44%
2000	39*	**39%**	1%	1%	1%	2%	4%	**28%**	0%	0%	2%	4%	5%	**18%**	2%	4%	5%	13%	21%	**17%**	1%	9.8%	23%	39%	48%	**20%**	1%	-2%	-1%	2%	12%
3000	129	**30%**	0%	0%	1%	1%	2%	**20%**	0%	0%	0%	0%	1%	**15%**	0%	0%	1%	2%	5%	**16%**	0%	0%	0%	6%	16%	**16%**	-2%	-2%	-2%	-2%	0%
4000	287	**18%**	0%	0%	1%	2%	5%	**16%**	0%	0%	0%	-1%	0%	**12%**	0%	1%	1%	1%	4%	**16%**	0%	0%	0%	0%	1%	**11%**	0%	0%	0%	0%	0%
5000	753	**15%**	0%	1%	1%	1%	1%	**13%**	0%	0%	0%	0%	1%	**11%**	0%	1%	1%	1%	1%	**13%**	-1%	0%	1%	0%	1%	**10%**	0%	-1%	-1%	-1%	0%
6000	1286	**15%**	-1%	-1%	-1%	0%	0%	**11%**	0%	0%	0%	0%	0%	**11%**	0%	0%	0%	0%	0%	**11%**	0%	0%	0%	0%	2%	**7%**	0%	0%	0%	0%	0%
7000	2020	**12%**	0%	0%	0%	0%	1%	**9%**	0%	1%	1%	1%	1%	**7%**	0%	1%	1%	1%	2%	**10%**	1%	0%	1%	1%	1%	**7%**	0%	0%	0%	0%	-1%
8000	2767	**12%**	0%	0%	-1%	-1%	0%	**7%**	0%	0%	0%	0%	0%	**6%**	0%	0%	0%	0%	1%	**9%**	0%	0%	0%	1%	1%	**5%**	0%	0%	0%	0%	0%
9000	3630	**10%**	1%	0%	-2%	-2%	-2%	**6%**	0%	0%	0%	0%	0%	**5%**	1%	1%	1%	1%	1%	**6%**	0%	0%	0%	0%	2%	**5%**	0%	0%	0%	0%	0%
10000	4480	**9%**	0%	0%	-1%	-1%	-1%	**5%**	1%	1%	1%	1%	1%	**4%**	0%	0%	0%	1%	2%	**4%**	0%	0%	0%	0%	1%	**5%**	0%	0%	0%	0%	-1%
15000	6707	**2%**	0%	0%	0%	0%	0%	**2%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**0%**	0%	0%	0%	0%	0%	**1%**	0%	0%	0%	0%	0%

*There appears to be a typo in the reported value for Reach 2 in CBEC's (2010) Table 5. This acreage value should be greater than 67 acres, but less than 129 acres.

Table 19-26. Percentage of years under baseline (base) conditions with average monthly San Joaquin River flows (above the Stanislaus confluence) greater than the specified flow, and the expected percent change under each of the unimpaired flows between 20% and 60%. Corresponding floodplain acreages are from Tuolumne River to the Stanislaus River (10 miles). Changes to frequency of occurrence which are greater than positive 10% are highlighted green, and changes to frequency of occurrence which are less than negative 10% are highlighted red (if applicable).

San Joaquin River Reach 3		February						March						April						May						June					
Flow (cfs)	Floodplain Acreage	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%
1000	8	**99%**	0%	0%	0%	0%	0%	**91%**	1%	2%	6%	6%	7%	**83%**	5%	15%	16%	16%	16%	**84%**	7%	13%	15%	16%	16%	**40%**	32%	40%	45%	50%	52%
2000	23	**59%**	-1%	-2%	-1%	6%	7%	**59%**	1%	5%	5%	16%	23%	**61%**	-4%	7%	21%	34%	37%	**52%**	16%	33%	39%	45%	45%	**26%**	20%	37%	45%	48%	54%
3000	29	**46%**	1%	1%	0%	0%	-1%	**44%**	0%	0%	-1%	5%	9.8%	**40%**	0%	5%	17%	33%	38%	**26%**	17%	38%	52%	61%	66%	**24%**	0%	20%	32%	41%	46%
4000	40	**37%**	1%	6%	5%	4%	5%	**41%**	-2%	-2%	-5%	-5%	1%	**29%**	0%	2%	7%	21%	34%	**20%**	1%	27%	43%	57%	65%	**21%**	1%	4%	17%	29%	39%
5000	100	**29%**	0%	0%	0%	6%	9%	**32%**	0%	-2%	-5%	-5%	0%	**24%**	0%	2%	2%	9%	16%	**20%**	0%	5%	26%	40%	55%	**18%**	1%	0%	5%	21%	28%
6000	213	**28%**	0%	-2%	-5%	-1%	4%	**26%**	0%	-4%	-5%	-6%	-6%	**17%**	0%	1%	2%	6%	9.8%	**16%**	1%	4%	7%	32%	44%	**15%**	0%	1%	0%	9.8%	23%
7000	286	**22%**	-1%	-1%	-2%	-2%	0%	**20%**	0%	0%	-2%	-1%	0%	**15%**	0%	1%	1%	1%	5%	**15%**	1%	2%	4%	15%	35%	**15%**	-1%	-1%	-1%	1%	11%
8000	400	**18%**	0%	-1%	-1%	1%	1%	**17%**	0%	0%	-1%	-2%	-1%	**13%**	0%	0%	0%	0%	1%	**13%**	0%	1%	4%	6%	24%	**12%**	0%	0%	-1%	0%	7%
9000	574	**16%**	0%	0%	0%	0%	1%	**15%**	0%	-1%	-1%	-2%	-2%	**11%**	0%	0%	0%	0%	4%	**11%**	1%	1%	1%	5%	9.8%	**12%**	0%	-1%	-1%	-2%	1%
10000	780	**15%**	0%	-1%	-2%	-2%	-1%	**12%**	0%	-1%	-1%	-1%	0%	**11%**	0%	0%	0%	0%	0%	**11%**	1%	1%	1%	2%	7%	**10%**	0%	-2%	-2%	-1%	1%
15000	1865	**6%**	0%	0%	-1%	0%	0%	**6%**	0%	0%	0%	0%	0%	**5%**	0%	0%	0%	0%	0%	**6%**	0%	0%	0%	0%	2%	**4%**	0%	0%	0%	1%	1%

Table 19-27. Percentage of years under baseline (base) conditions with average monthly San Joaquin River flows at Vernalis greater than the specified flow, and the expected percent change under each of the unimpaired flows between 20% and 60%. Corresponding floodplain acreages are from Mossdale (Interstate-5 Bridge) to the confluence with the Stanislaus River (16 miles). Changes to frequency of occurrence which are greater than positive 10% are highlighted green, and changes to frequency of occurrence which are less than negative 10% are highlighted red (if applicable).

San Joaquin River Reach 4		February						March						April						May						June					
Flow (cfs)	Floodplain Acreage	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%	**Base**	20%	30%	40%	50%	60%
1000	62	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**100%**	0%	0%	0%	0%	0%	**90%**	6%	9%	9%	9%	9%
2000	75	**79%**	-5%	-2%	2%	4%	6%	**80%**	-6%	1%	5%	9%	11%	**85%**	2%	12%	13%	13%	13%	**85%**	7%	11%	12%	13%	15%	**57%**	11%	18%	24%	27%	33%
3000	83	**56%**	-1%	-2%	-5%	2%	6%	**63%**	-5%	1%	1%	11%	18%	**72%**	0%	9%	13%	23%	26%	**71%**	7%	18%	22%	27%	27%	**41%**	13%	22%	30%	33%	38%
4000	91	**43%**	5%	6%	5%	4%	2%	**45%**	2%	0%	4%	9.8%	12%	**56%**	-2%	6%	17%	24%	32%	**52%**	9.8%	23%	34%	35%	43%	**26%**	4%	28%	35%	40%	46%
5000	99	**34%**	1%	9%	7%	9%	9.8%	**43%**	-1%	-1%	1%	1%	6%	**46%**	-5%	-1%	6%	22%	30%	**45%**	2%	17%	29%	40%	41%	**23%**	1%	9.8%	28%	37%	43%
6000	108	**30%**	0%	1%	7%	9%	11%	**39%**	-1%	-4%	-4%	-2%	2%	**34%**	-4%	-1%	6%	21%	29%	**23%**	9.8%	27%	39%	50%	61%	**21%**	0%	2%	12%	28%	37%
7000	125	**28%**	0%	-1%	-2%	6%	9.8%	**34%**	1%	-1%	-5%	-4%	-2%	**26%**	1%	2%	4%	12%	27%	**21%**	0%	21%	33%	44%	54%	**20%**	0%	0%	5%	20%	32%
8000	231	**27%**	-1%	0%	-2%	0%	5%	**29%**	0%	-2%	-5%	-6%	0%	**20%**	2%	5%	4%	9.8%	17%	**20%**	1%	5%	21%	35%	48%	**16%**	0%	0%	2%	12%	26%
9000	353	**21%**	0%	-1%	-1%	0%	2%	**18%**	4%	2%	1%	2%	2%	**17%**	0%	0%	1%	4%	9%	**17%**	0%	2%	13%	32%	41%	**15%**	0%	-1%	-1%	9%	16%
10000	500	**17%**	0%	0%	0%	1%	2%	**18%**	0%	1%	-1%	0%	2%	**13%**	1%	0%	1%	4%	6%	**13%**	2%	4%	7%	26%	40%	**13%**	0%	0%	0%	2%	11%
15000	908	**11%**	0%	-2%	-2%	-1%	-1%	**9%**	0%	0%	0%	0%	0%	**6%**	0%	0%	1%	1%	2%	**9%**	1%	2%	4%	4%	9%	**6%**	0%	1%	1%	1%	2%

Stanislaus River Floodplain Evaluation Results

Baseline: Under existing conditions on the Stanislaus River, April and May experience floodplain inundation flows most often, with average monthly flows greater than 1,000 cfs (floodplain inundation threshold) occurring approximately 60% and 59% of the years, respectively. Each of the other months between February and June have a lower frequency of floodplain inundation, with February having the lowest frequency (10%) of monthly average flows over 1,000 cfs. Interestingly though, February also has the highest frequency (4%) of monthly average flow greater than 3,000 cfs (326 acres) (Table 19-22).

20-60% Unimpaired Flow: During March, only the 60% unimpaired flow provides an increase of 10% or more (12%) in the amount of years with monthly average flows which are greater than 1000 cfs. However, even the 60% unimpaired flow in March does not provide a significant increase in the amount of time that monthly average flows are greater than 1,250 cfs (19 acres). During the other months from February through June, the higher unimpaired flows provide greater increases compared to the lower unimpaired flows in the amount of time that monthly average flows are greater than the floodplain inundation threshold. May is the month with the largest increase in floodplain flows, with monthly average flows greater than 2,000 cfs (161 acres) occurring approximately 51% more often than baseline under the 60% unimpaired flow (Table 19-22).

Tuolumne River Floodplain Evaluation Results

Baseline: Under existing conditions on the Tuolumne River, March and April experience floodplain inundation flows most often, with average monthly flows greater than 1,100 cfs (floodplain inundation threshold) occurring approximately 55% and 44% of the years respectively. Each of the other months between February and June have a lower frequency of floodplain inundation, with May and June having the lowest frequency (35% and 24% respectively) of monthly average flows greater than 1,100 cfs (Table 19-23).

20-60% Unimpaired Flow: During February and March, modeling does not indicate that the alternative unimpaired flows evaluated would produce significant floodplain benefits. During April through June, the higher unimpaired flows provide greater increases compared to the lower unimpaired flows in the amount of time that monthly average flows are greater than the floodplain inundation threshold. May is the month with the largest increase in floodplain flows, with monthly average flows greater than 1,500 cfs (152 acres) occurring approximately 78% more often than baseline under the 60% unimpaired flow (Table 19-23).

Merced River Floodplain Evaluation Results

Baseline: Under existing conditions on the Merced River, the frequency of monthly average flows greater than 1,000 cfs (floodplain inundation threshold) occurs similarly during February through June ranging between 5% (April) and 29% (February) (Table 19-24).

20-60% Unimpaired Flows: The 20-60% unimpaired flows result in significant increases in the frequency of flows greater than 1,000 cfs during the months of April, May, and June, but do not increase the occurrence of these events during February or March. During April through June, the higher unimpaired flows provide greater increases compared to the lower unimpaired flows in the amount of time that monthly average flows are greater than the floodplain inundation threshold.

May is the month on the Merced River with the largest increase in floodplain flows, with monthly average flows greater than 1,000 cfs occurring 70% more often under the 60% unimpaired flow (Table 19-24).

San Joaquin River Floodplain Evaluation Results

Baseline: Reaches 1 and 2 make up the section of the SJR between the Merced and Tuolumne Rivers. Under baseline flow conditions, floodplain inundation occurs most frequently during February and least frequently during June. Under existing channel configuration floodplain inundation occurs as low as 1,000 cfs (67 acres). Between 1,000 and 4,000 cfs there is a slow rate of increase in floodplain acreage with additional flow. Above 4,000 cfs (287 acres) the rate floodplain acreage increases rapidly (see Table 19-21). Under baseline conditions, monthly average flows greater than 4,000 cfs occur 18%, 16%, 12%, 16%, and 11% of the years during the 82-year period for February, March, April, May, and June respectively (Table 19-25).

The LSJR Reach 3 is located between the Tuolumne and the Stanislaus Rivers. Under existing channel configuration there is small amount of floodplain inundated at flows as low at 1000 cfs (8 acres). From 1,000 cfs to 7,000 cfs there are minimal gains to floodplain inundation with increasing flow. Above 7,000 cfs (286 acres) there is an increased rate of floodplain inundation as flows increase (see Table 19-21). Floodplain inundation under baseline conditions is similar from February to May, and then drops off in June. Monthly average flows greater than 1000 cfs occur 99%, 91%, 83%, 84%, 40% of the of the years during the 82-year period for February, March, April, May, and June respectively. Monthly average flows greater than 7,000 cfs occur 22%, 20%, 15%, 15%, and 15% of the years during the 82-year period for February, March, April, May, and June respectively (Table 19-26).

Reach 4 is located in the LSJR from the Stanislaus River confluence to Mossdale. In Reach 4, monthly average Vernalis flow greater than 7,000 cfs (125 acres) occur 28%, 34%, 26%, 21%, and 20% of the years during February, March, April, May, and June respectively. In general, each month from February through June has a similar pattern of monthly average flows that inundate floodplain, except that June has a lower frequency of lower flows. For example, a monthly average flow of 2,000 cfs (75 acres) occurs approximately 80% of the time during February through May, but only occurs 57% of years during June (Table 19-27).

20-60% Unimpaired Flow: Above the Tuolumne River in Reaches 1 and 2 significant floodplain improvements occur primarily under the 40%-60% unimpaired flows. These improvements in the frequency of floodplain inundation occur at flows between 1,000 cfs (67 acres) and 3,000 cfs (129 acres), and the largest floodplain improvements occur in May under the 40%-60% unimpaired flows. Monthly average flow events above 4,000 cfs (287 acres) do not increase substantially under any of the alternatives (Table 19-25).

Between the Stanislaus and Tuolumne Rivers (Reach 3), floodplain improvements from increased unimpaired flows primarily occur during April through June. The higher unimpaired flows produce larger increases in floodplain inundation compared to the lower unimpaired flows. During May, the 50% and 60% unimpaired flows increase floodplain inundation events greater than 7,000 cfs (286 acres) by 15% and 35% respectively (Table 19-26).

In Reach 4, significant improvements to the frequency of monthly average flows above 7,000 cfs (125 acres) occur under the 50% and 60% unimpaired flows in April, occur under the 30%-60% unimpaired flows in May, and occur under the 50% and 60% unimpaired flows in June. May is the month on the LSJR with the largest increase in floodplain flows, with monthly average flows greater than 7,000 cfs occurring 54% more often under the 60% alternative (Table 19-27).

Summarized Floodplain Results

When considering floodplain results on different rivers and different times of the year, it becomes difficult to provide an overall picture of potential floodplain benefits. One way to summarize the floodplain benefits of the evaluated unimpaired flows is to consider a data output commonly referred to as acre-days (see USFWS 2014). This measurement is the number of acres inundated each day, and then summed over an identified time period. Table 19-28 provides a summary of the acre-days of floodplain inundation in the three tributaries that occur under baseline, and under different unimpaired flows during February through June. The table also shows the percentage increase achieved under each percent of unimpaired flow, relative to baseline. There is an overall 35 percent increase in floodplain inundation, from 39,292 acre-days to 53,208 acre-days at 40 percent of unimpaired flow. The percent increase in floodplain inundation is 16 percent and 74 percent, respectively, for 30 and 50 percent of unimpaired flow.

Table 19-28. Annual average floodplain inundation in acre*days and percent increase during February through June for baseline and different unimpaired flow percentages.

Percent of Unimpaired Flow	Unit	Stanislaus	Tuolumne	Merced	Total
Baseline	Acre*Days	4,881	27,668	6,742	39,292
20% UF	Acre*Days	4,475	27,899	7,016	39,390
	Percent Increase	-8%	1%	4%	0%
30% UF	Acre*Days	5,618	31,882	7,895	45,395
	Percent Increase	15%	15%	17%	16%
40% UF	Acre*Days	7,509	36,644	9,055	53,208
	Percent Increase	54%	32%	34%	35%
50% UF	Acre*Days	11,805	44,426	12,055	68,287
	Percent Increase	142%	61%	79%	74%
60% UF	Acre*Days	16,818	53,936	15,879	86,634
	Percent Increase	245%	95%	136%	120%
UF = unimpaired flow					

A critically important time period for floodplain inundation, and also the time period that achieves the greatest benefit from the flow proposal, is the April through June period. Floodplain inundation does not change much during February and March because flows are relatively high during those months already under baseline. Table 19-29 provides a summary of acre-days of floodplain inundation that occur under baseline, and also for 20 to 60 percent of unimpaired flow, for the April through June period. The table also shows the percent increase achieved under each percent of unimpaired flow, relative to baseline. There is an overall 82 percent increase in floodplain inundation, from 21,034 acre-days to 38,352 acre-days at 40 percent of unimpaired flow in the three tributaries. The percent increase in floodplain inundation is 37 percent and 152 percent, respectively, for 30 and 50 percent of unimpaired flow.

Table 19-29. Annual average floodplain inundation in acre*days and percent increase during April through June for baseline and different unimpaired flow percentages.

Percent of Unimpaired Flow	Unit	Stanislaus	Tuolumne	Merced	Total
Baseline	Acre*Days	3,217	13,809	4,008	21,034
20% UF	Acre*Days	2,627	14,676	4,153	21,456
	Percent Increase	-18%	6%	4%	2%
30% UF	Acre*Days	3,844	19,873	5,113	28,831
	Percent Increase	19%	44%	28%	37%
40% UF	Acre*Days	5,716	26,046	6,589	38,352
	Percent Increase	78%	89%	64%	82%
50% UF	Acre*Days	9,543	33,939	9,507	52,988
	Percent Increase	197%	146%	137%	152%
60% UF	Acre*Days	13,909	41,689	13,016	68,615
	Percent Increase	332%	202%	225%	226%

UF = unimpaired flow

As is the case for potential temperature improvements, the benefits of floodplain inundation are greatest during dry and critically dry years. Table 19-30 shows floodplain inundation in the Tuolumne River for baseline and for each 10 percent increment of unimpaired flow from 20 to 60 percent for each water year type. Under baseline, there was no floodplain inundation in critically dry years, whereas under 40 percent unimpaired flow there are 4,172 acre-days of floodplain inundation from April through June. In dry years, floodplain inundation increases by a factor of 14 (1,390 percent), from 602 days to 8,964 acre-days of floodplain inundation. Improvements are similarly large for the Merced River, where there is no floodplain inundation under baseline conditions in below normal, dry, or critically dry years. Improvements are smaller in the Stanislaus River because flows are already relatively high in dry and critically dry years under baseline.

Table 19-30. Average annual floodplain inundation in acre*days and percent increase during April through June for baseline and different unimpaired flow percentages for the Tuolumne River.

Percent of Unimpaired Flow	Unit	All Year Types	Wet	Above Normal	Below Normal	Dry	Critical
Baseline	Acre*Days	13,809	41,553	7,501	555	602	0
20% UF	Acre*Days	14,676	43,300	9,318	964	202	0
	Percent Increase	6%	4%	24%	74%	-66%	NA
30% UF	Acre*Days	19,873	48,199	19,423	8,465	2,758	1,011
	Percent Increase	44%	16%	159%	1424%	358%	NA
40% UF	Acre*Days	26,046	50,334	30,383	19,862	8,974	4,172
	Percent Increase	89%	21%	305%	3477%	1390%	NA
50% UF	Acre*Days	33,939	56,322	41,223	31,160	16,617	9,411
	Percent Increase	146%	36%	450%	5511%	2658%	NA
60% UF	Acre*Days	41,689	63,025	50,896	40,833	24,441	15,187
	Percent Increase	202%	52%	579%	7253%	3957%	NA

UF = unimpaired flow

Note: The percent increase could not be calculated for some river and year type combinations because there was 0 Acre*Days of floodplain under baseline. These value are replaced with NA.

As indicated by these summary tables and the previously discussed floodplain results tables, there is tremendous potential to increase floodplain habitat in these rivers under the proposed project.

19.3.4 Summary and Conclusions of Floodplain Inundation Evaluation

The results of this floodplain analysis indicate that providing more flow with a more natural regime during the February through June time period will significantly increase the amount of floodplain habitat which is available to native fish, and that higher unimpaired flows will produce greater benefit, in terms of floodplain frequency and magnitude (and presumably duration), compared to lower unimpaired flows or baseline conditions. In general, floodplain inundation will increase the most (compared to baseline) during the months of April, May, and June under the evaluated unimpaired flows.

In the last 2 decades, numerous studies have demonstrated that both aquatic and riparian ecosystems benefit from dynamic connectivity between rivers and their floodplains (see Jeffres et al. 2008). For example, riparian species benefit from nutrients mobilized by inundation of floodplain areas (Junk et al. 1989), while riverine species benefit by having access to the floodplain for foraging, spawning, and as a refuge from high velocities in the river during high flow events (Moyle et al. 2007).

Floodplain habitats in the Central Valley have been found to have a positive effect on growth of juvenile Central Valley salmonids (Sommer et al. 2001; Sommer et al. 2005; Jeffres et al. 2008), and larger and faster growth has been associated with increased survivorship in river and to adulthood (Bond et al 2008; Healey 1982; Fritts and Pearsons 2006; Mesick and Marston 2007a; Parker 1971; Unwin 1997; Ward et al 1989; Zabel and Williams 2002). Additionally, fish yields in watersheds generally increase when water surface area in floodplains is increased (USFWS 2014; Bayley 1991 as cited in Jeffres et al. 2008).

Implementation of the proposed project will produce substantial increases in floodplain habitat which is available to native fish and wildlife populations, and it is expected that there will be significant positive population responses by native salmonids, and other native fishes.

19.4 SalSim

19.4.1 Introduction of SalSim

To provide insight into potential management decisions being evaluated for this Bay-Delta Plan update, the State Water Board staff used a life-history population simulation model for fall-run Chinook salmon originating from the SJR and its upper three east-side salmon bearing tributaries (Stanislaus, Tuolumne, and Merced Rivers). This model is called SalSim and was developed by the CDFW, AD Consultants, and a variety of other modeling and fisheries experts (CDFW 2013a; CDFW 2014). The State Water Board used SalSim to explore and compare a variety of flow scenarios in order to assess the response of fall-run Chinook salmon production from the Stanislaus, Tuolumne, and Merced Rivers that may have occurred if these different flow scenarios were implemented in the past. It is important to understand that this model does not predict what is expected to occur in the future. Instead, the model backcasts how salmon populations may have been different in the past (1994-2010) if water management was different in the three east-side tributaries.

Use of SalSim and Advisory for this Bay-Delta Plan Update

During the exploration and use of this model State Water Board staff discovered that the treatment of two of the most important salmon habitat attributes related to flow in the project area, water temperature and floodplain inundation, are not represented by the model in a manner that is consistent with current scientific information. Consequently, SalSim appears to underrepresent the benefit of habitat improvements related to floodplain and water temperature conditions during the spring time period that result from different flow scenarios which were evaluated for this project. Specifically, in SalSim, the downstream movement of juvenile salmon is slowed down when they pass inundated floodplains, which results in a later date and larger size of entry into the SJR and Delta, where a larger size improves survival. However, SalSim does not increase the growth rate of these fish when they are “on a floodplain”. Recent literature (see Jeffres et al. 2008) indicates that growth rates of juvenile salmon on a floodplain can be significantly greater than juvenile salmon rearing in the adjacent river channel. However, exactly how much faster salmon grow on a floodplain depends on many variables that are not completely understood in California, which may explain why SalSim does not contain a relationship between growth rates and floodplain use. By not having increased growth rates during floodplain use, SalSim likely underestimates the direct benefit of floodplain inundation to juvenile salmon survival. Additionally, negative temperature effects from warm water on juvenile salmon survival are under-sensitive during the spring time period in SalSim. For example, the density-independent mortality function (CDFW 2014) for juvenile salmon in SalSim calculates daily survival probabilities near 100% at daily maximum temperatures in excess of 40°C at flows of 550 cfs for salmon 65 mm in length. Temperatures above 30°C and certainly above 40°C are lethal to salmonids during exposure times of seconds or minutes (EPA 2003). Temperature modeling results presented in this chapter indicate that harmful and lethal temperatures can be dramatically reduced during the February through June time period for the proposed project. However, the SalSim model does not appear to apply the appropriate survival response to the reduction of harmful temperatures during the spring time period under some flow and temperature combinations and is likely underrepresenting the benefits of some of the scenarios evaluated. These observations suggest that SalSim functions should be updated to better respond to temperature and floodplain conditions.

These SalSim limitations were not unexpected. The developers of SalSim described in their documentation of SalSim (CDFW 2014) that their "ability to estimate average rates as a function of environmental variation, the key factors being local flow and temperature variables of the river system, is limited by the availability and accuracy of relevant existing empirical data".

Although SalSim's response to potential temperature and floodplain improvements appears to be conservative in nature, model runs by State Water Board staff were informative. Along with our separate temperature analyses, this model helped to evaluate the tradeoffs that are present in water management decisions. Specifically, the model enumerated tradeoffs between the needs of different life stages in the fall time period versus the spring time period. The use of this model informs some of the concepts behind the flow shifting paradigms that may occur through adaptive implementation.

Executive Summary of SalSim

The following executive summary was provided in CDFW's (2014) SalSim documentation:

> "SalSim is a life-history population simulation model for fall-run Chinook salmon originating from the San Joaquin River (SJR) and its upper three east-side salmon bearing tributaries (Stanislaus, Tuolumne, and Merced Rivers). Additionally, SalSim includes functionality for simulating the SJR below Friant Dam. This functionality is currently inactive relative to salmon production due to salmon paucity, but can be activated when that part of the river system begins producing salmon. SalSim does model this portion of the river system's temperatures as a function of flow, storage and meteorological conditions.
>
> The primary objectives of SalSim are to provide a modeling tool that will:
>
> - Serve as a decision support tool for CDFW, regulators and water managers as they seek to restore fall-run Chinook salmon in the SJR Basin;
> - Be used to identify, establish, and evaluate instream flow levels (both in-tributary and mainstem) necessary to enhance habitat conditions for fall-run Chinook salmon;
> - Have broad scientific community acceptance;
> - Have broad management utility and confidence;
> - Be useable by a variety of interested users; and
> - Be fully transparent.
>
> SalSim is essentially three models functioning together as one overall model. The three sub-models include:
>
> - A water operations model that accounts for water movement into and out of the lower rim dam reservoirs on the mainstem SJR (Friant) and the principal east-side tributaries including the Stanislaus River (New Melones), the Tuolumne River (New Don Pedro), and the Merced River (New Exchequer).
> - A water temperature response model that predicts reservoir release temperatures as a function of reservoir storage, ambient air temperature and release patterns. The model predicts water

temperature responses for the lower reaches of each tributary and the entire mainstem of the SJR from Friant downstream to Mossdale.

- A salmon production model, which predicts salmon abundance beginning with the egg stage and extending through the entire salmon life cycle to adults returning inland to spawn 2 to 4 years later.

SalSim is intended as a user-friendly web-based application. Users can interactively perform simulation runs for different water management scenarios, view results on the screen (GUI output) and then download results for further analysis using third party software, such as, HEC-DSS (USACE Data System Storage) and Excel (via CSV output files).

SalSim can also use external data generated by other basin-wide operational and/or water temperature models such as CALSIM II and the San Joaquin River Basin-wide Water Temperature Model (a.k.a. HEC-5Q)".

Model Use Advisory Issued by the Developers

The following model use advisory was provided in CDFW's (2014) SalSim documentation:

> "The SalSim model development team includes this advisory in order to provide clear direction in the use of SalSim. There are two overarching concerns we address below to moderate model user's expectations. The first precaution in SalSim's use is that SalSim, as with all models that have some mechanistic components, is an idealization of the processes occurring at a particular spatial and temporal scale: in SalSim's case that scale pertains to estimating daily growth, mortality, and movement rates. Further, our ability to estimate average rates as a function of environmental variation, the key factors being local flow and temperature variables of the river system, is limited by the availability and accuracy of relevant existing empirical data. In our opinion, given the limitations of these data, SalSim represents best modeling practices and, hence, the best available science for modeling the impacts of localized temperature and flow effects on the outmigrating SJR fall-run Chinook salmon. If the model user wants to modify the system to see a resulting average change in salmon production, currently there is no better tool available to perform this task.
>
> The second precaution in SalSim's use is that the parameters in SalSim are fitted using a "backcasting" approach and hence SalSim should not been seen as a model that is optimized for providing the most accurate possible forecasts. Rather, SalSim has been constructed as a tool to explore and compare scenario's and provide insights to answering "what if …?" questions. That is, SalSim allows the model user to change historical conditions, as represented in the model, in order to assess the response in the system that is most likely to occur. Put another way, SalSim should not be considered an accurate predictor of future salmon populations because, i) there are too many variables that cannot be reliably forecasted (i.e. future year ocean conditions and/or water year types, etc.) and ii) the underlying empirical data used to build SalSim has a considerable unexplained variability due to the absence of information on the availability of relevant factors (e.g. local availability of food for local populations), the use of laboratory rather than field data to estimate certain effects such as temperature effects on mortality and inherent variability itself in the measured environmental data (e.g. local flow is an average and cannot account for side-eddies and highly localized pools). That a full life cycle model has a high level of unexplained variability for an animal inhabiting such a diverse geographic life history spanning three ecosystems (i.e. inland, delta, and ocean) is to be expected.
>
> SalSim model developers fully understand that it is important to bound model predictions to frame uncertainty in a formal way. This has not yet been developed for SalSim predictions due to time and funding limitations. This, along with formal model parameter sensitivity assessment to refine the variance-bias trade-off in identifying the appropriate number of variables to include in a simulation model, is planned for future model versions pending funding availability. Despite this shortcoming, the model developers firmly believe that SalSim is nonetheless the best available tool to inform SJR fall-run Chinook salmon management decision making with the understanding that the results are couched in terms of what would be expected on average even though extremes (i.e. higher than or

lower than) might occur given the unexplained variability present in existing empirical data used to build SalSim. This type of situation where management decisions are made despite considerable uncertainties in the data is common in public health issues, such as analyses involving infectious diseases and vaccines, etc. Thus data uncertainty should not be used as an excuse not to use SalSim or to make management decisions.

It is worth noting that SalSim was not created in a vacuum. Rather, available empirical data combined with expert opinion and use of industry accepted (i.e. well established and proved) mathematical and statistical procedures and formulations coupled with formal peer review were used to build a state-of-the-art simulation model. SalSim predicts salmon population response given a suite of physical (abiotic) and biological (biotic) factors to visualize what would occur on average in the future if, and only if, the past were perfectly replicated in the future absent those changes the model user chooses to make.

Despite these model use precautions, SalSim developers are confident that the results arising from model runs represent on average what is most likely to happen if the defined environmental conditions that the model user chose had actually occurred. However, individual year nuances that are unforeseen cannot be accounted for in SalSim. Thus, it is important for model users to understand that SalSim results represent “on-average” conditions given the underlying likelihood survival probabilities occur that were developed per the empirical data available at the time of SalSim development.

A question arises in how to interpret various scenarios where the user conducts several runs making incremental changes in the system. It is not our intention that model runs be compared in terms of the specific number of salmon produced. Rather, various scenarios should be compared more broadly by looking at the percentage change in annual salmon production (foremost would be the percent change in adults and secondary would be the percent change in juveniles produced by each tributary, then total juveniles reaching the Delta, then entering the ocean). This analysis would be more of a qualitative evaluation versus a strictly quantitative comparison.

In summary, SalSim represents the best scientific tool available, gives both a qualitative and quantitative understanding of salmon life history and the underlying physical and biological systems influencing salmon production, and use of SalSim is substantially more reliable than making uninformed (i.e. uneducated) guesses about what would be expected to happen on average if the physical environment were changed from that which existed historically. This type of “backcasting” modeling is consistent with the philosophy employed by other widely used simulation models, such as CALSIM II, HEC-5Q, DSM2, to name a few. The idea is that by learning from the past we could better plan for the future.

Thus the State Board, and/or other management making decision bodies, are urged to use SalSim both to better inform present decision making and to inform decisions on how best to collect data in the future to get the most “bang for the buck” from the new information that is collected.”

19.4.2 Methods of State Water Board SalSim Evaluation

The State Water Board used SalSim to explore and compare a variety of flow scenarios in order to assess the response of fall-run Chinook salmon production from the Stanislaus, Tuolumne, and Merced Rivers that may have occurred if these different flow scenarios were implemented in the past. For this evaluation, total adult salmon production (defined below) was used as the primary comparative metric between each of the flow scenarios. To inform the iterative process of testing different scenarios other metrics such as egg production, egg survival, juveniles leaving each tributary, and juvenile survival were used to inform subsequent scenarios.

The following method subsections provide additional details regarding the inputs and outputs used for the State Water Board SalSim modeling runs and evaluation.

Methods: Flow and Temperature Inputs to SalSim

Flow and temperature inputs used in the State Water Board's SalSim runs can be organized in two basic categories: 1) inputs to SalSim that came from modeling used in the SED evaluation, and 2) inputs generated specifically for SalSim flow shifting scenarios. The following subsections describe the differences in temperature and flow inputs used for these SalSim runs.

(1) Inputs from flow and temperature modeling as used in the SED

SED Flow Modeling

The State Water Board developed the WSE model to simulate the baseline and LSJR alternatives for water years 1922-2003 and to determine the effects on reservoir operations, water supply diversions, and river flow for each of the eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers) and flow and salinity at Vernalis on the SJR. The scientific basis for the WSE model is described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and the detailed methods and results for the LSJR alternatives are presented in Appendix F.1, *Hydrologic and Water Quality Modeling*. The WSE model was used to inform the SED to analyze project effects in accordance with CEQA requirements.

The WSE modeling runs which were used in the SED and in SalSim are referred to as unimpaired flow runs in the following SalSim sections, and are labeled SB20%UF for example for the 20% unimpaired flow run. This is to distinguish those scenarios from other scenarios where further consideration was given to temperature, flow, and storage to optimize adult salmon production. These additional modeling runs are referred to as flow shifting runs, and are described below in more detail.

SED Temperature Modeling

To model effects on temperature in the LSJR and three eastside tributaries for the SED, the State Water Board used the San Joaquin River Basin-Wide Water Temperature and EC Model (shorthand used here is SJR HEC-5Q model or temperature model) developed by a group of consultants between 2003 and 2008 through a series of CALFED contracts that included peer review and refinement (CALFED 2009). The temperature model was most recently updated by the CDFW and released in June of 2013 (CDFW 2013b).

The temperature model uses the Hydrologic Water Quality Modeling System (HWMS-HEC5Q), a graphical user interface that employs HEC-5Q, the USACE HEC flow and water quality simulation model, to model reservoir and river temperatures subject to historical climate conditions and user defined operations. The temperature model was designed to provide a SJR Basin-wide evaluation of temperature response at 6-hour intervals for alternative conditions, such as operational changes, physical changes, and combinations of the two. The extent of the model includes the Merced, Tuolumne, and Stanislaus River systems from their LSJR confluences to the upstream end of their major reservoirs (i.e., McClure, Don Pedro, and New Melones, respectively). The upstream extent of the model on the LSJR is the Merced River confluence. The downstream extent of the model is the LSJR at Mossdale. The model simulates the reservoir stratification, release temperatures, and downstream river temperatures as a function of the inflow temperatures, reservoir geometry and outlets, flow, meteorology, and river geometry. Calibration data was used to accurately simulate temperatures for a range of reservoir operations, river flows, and meteorology.

The temperature model interfaces with CALSIM (see Appendix F.1, *Hydrologic and Water Quality Modeling*) or monthly data formatted similarly to CALSIM output. A pre-processing routine converts the monthly output to a format compatible with the SJR HEC-5Q model. This routine serves two purposes: 1) to allow the temperature model to perform a long-term simulation compatible with the period used in CALSIM II, and 2) to convert monthly output to daily values used in the temperature model.

Using the monthly output from the WSE model (see Appendix F.1), the "CALSIM to HEC-5Q" temperature model pre-processor was used by the State Water Board, and the temperature model was run to determine the river temperature effects of different flow scenarios within the Stanislaus, Tuolumne, Merced, and Lower San Joaquin Rivers. The temperature model was run for the period 1970 through 2003, a period with sufficient length and climatic variation to determine the effects of the LSJR alternatives on river temperatures.

The HEC-5Q modeling outputs that were used for the State Water Board's SED evaluation were used as SalSim inputs for the unimpaired flow runs.

(2) Flow Modeling Modifications for the Purposes of SalSim

There are three additional flow and temperature modeling steps that were performed for the purpose of evaluating SalSim scenarios. First the WSE model was extended to run through 2010. Second, a scenario was evaluated where 25% of the February through June flow requirement water was shifted to other times of the year. Third, the temperature operations function in the temperature model (see CDFW 2013b: Appendix B, *System Operation for Temperature Control*) was used to set temperature and flow targets during all times of the year, and water from the February through June flow requirement could be used to try to meet these targets. For each of these modifications, all other constraints such as existing regulatory requirements, diversions, and end of year storage remained in effect as described in the WSE model. These three modeling steps are described below.

Extending the WSE Model

As described above, the State Water Board's WSE model operates from 1922 to 2003. SalSim is designed to operate from 1994 to 2010. To make full use of SalSim, the WSE model period was extended through 2010. This was accomplished by using the historical reservoir inflows, and estimated monthly data for downstream local inflows, return flows, and water supply diversions, using CALSIM inputs from years with similar hydrology (Table 19-31; also see Chapter 21, *Drought Evaluation*). Output parameters, such as diversions and flows, were then calculated within the WSE model as described in Appendix F.1, *Hydrologic and Water Quality Modeling*.

Table 19-31. Surrogate years that were used to extend the WSE model for the 2004 to 2010 time period

Water Year	Surrogate Year
2004	1972
2005	1980
2006	1998
2007	1994
2008	1930
2009	1971
2010	1973

Shifting 25% of the February through June Flow Requirement

As described in the SED, the proposed project allows for adaptive implementation actions that could shift a portion of the required February through June unimpaired flows to other times of the year to prevent adverse effects to fisheries, including temperature. To test the effect of shifting part of the annual water requirement for LSJR Alternative 3 (40% unimpaired flow) to other times of the year, a SalSim run (called SB40%MaxFS) was completed for this report which shifted 25% of required unimpaired flow to the months of September through December. Of the water that was shifted, 15% was shifted to September, 20% was shifted to October, 25% was shifted to November, and 40% was shifted to December (to total 100% of the shifted water). All rivers and water year types were treated the same. Within each month the shifted flow was distributed evenly for each day. Surface water supply allocations were calculated in the WSE model based on start of October storage that did not include the shifted water. This flow shifting modeling scenario was only done for the 40% unimpaired flow alternative.

Shifting Based on Defined Temperature and Flow Targets

As discussed above, the temperature model has a temperature operations function (see CDFW 2013b: Appendix B, *System Operation for Temperature Control*) which has the capability of operating the reservoirs to try to meet downstream temperature and flow targets. A SalSim modeling run (called SB40%OPP) was made using inputs from a temperature operations run made in the temperature model. This temperature operations run was used to determine if further refined temperature and flow management scenarios, compared to the unimpaired flow SED runs, resulted in improved salmon production in SalSim. The 40% unimpaired flow SED run (LSJR Alternative 3), and the 40% temperature operation run, both used the same volumes of water annually for fish benefit purposes, which is equal to the percent of unimpaired flow objective (40%) during the February through June time period. The SED run primarily allocates the "fish benefits water" during the February through June time period as described in Appendix F.1, *Hydrologic and Water Quality Modeling*. On the other hand, the temperature operations run treats the "fish benefits water" as a bank account and allocates it to meet temperature targets and flow constraints throughout the entire year. Diversions and end of year storage remained the same between the 40% temperature operations run and the 40% unimpaired flow SED run. However, other assumptions like State Water Project and Central Valley Project exports, and flow entering the Stockton Deep Water Ship Channel, were recalculated according to the standard WSE model and SalSim procedures.

The temperature targets and the flow constraints used in the temperature operations run are shown in Attachment 2.

Methods: SalSim Evaluation Criteria

For this evaluation, changes in annual SJR Basin (Stanislaus, Tuolumne, and Merced Rivers) total adult salmon production was used as the primary comparative metric. This metric includes annual SRJ Basin produced commercial and recreational harvest, annual SJR Basin produced salmon that stray out of basin as adults, and annual total SJR Basin produced escapement (hatchery and in-river). This metric does not include adult strays that come into the basin from other watersheds, because it is a set number in SalSim for each year that does not change based on the scenario. To inform the iterative process of testing different scenarios other metrics such as egg production, egg survival, juveniles leaving each tributary, and juvenile survival were used to inform subsequent scenarios.

19.4.3 Results of the SalSim Evaluation

The SalSim results for the unimpaired flow cases (as used in the SED analysis) and the two 40% flow shifting cases indicate that as percent of unimpaired flow is increased, annual average total adult salmon production would have also increased during the 1994 to 2010 time period (Figure 19-13, Figure 19-14, and Table 19-32).

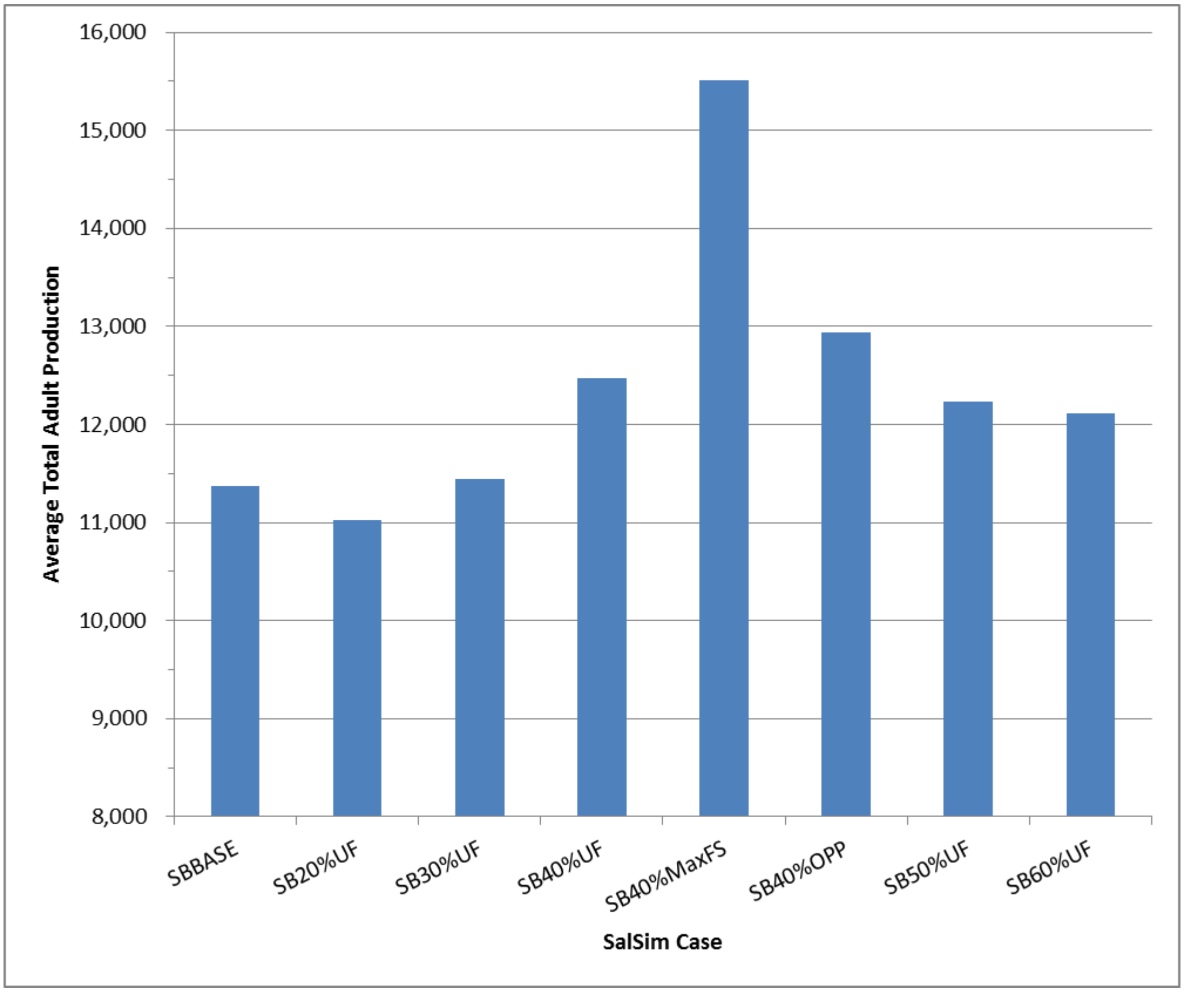

Figure 19-13. SalSim average total adult fall-run Chinook salmon production per year from 1994 to 2010 resulting from different flow cases. These results are the combined results for the Stanislaus, Tuolumne, and Merced Rivers.

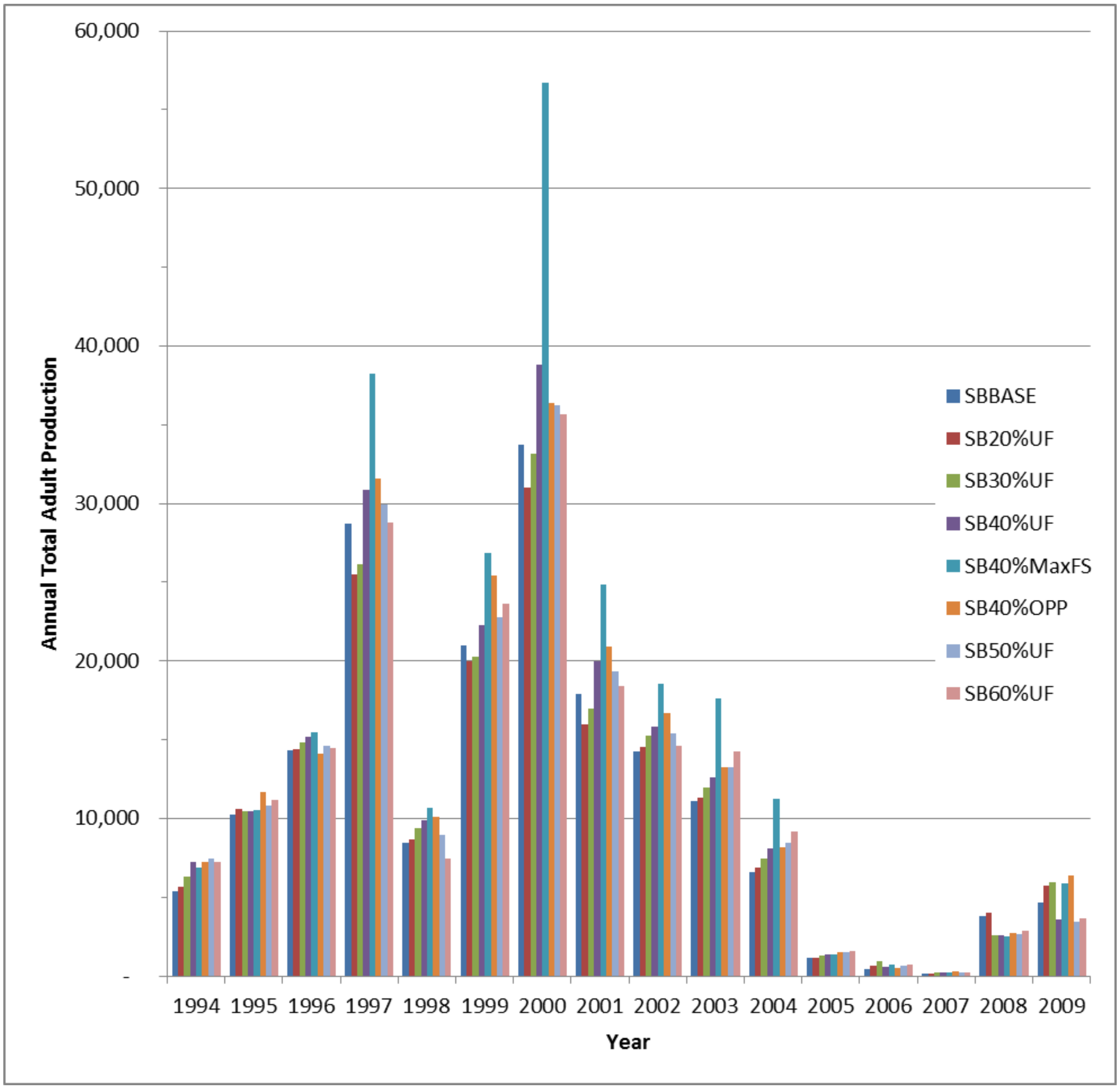

Figure 19-14. SalSim annual total adult fall-run Chinook salmon production from 1994 to 2010 resulting from different flow cases. These results are the combined results for the Stanislaus, Tuolumne, and Merced Rivers.

Table 19-32. SalSim Annual Total Adult Fall-Run Chinook Salmon Production for Different Flow Cases. These results are the combined results for the Stanislaus, Tuolumne, and Merced Rivers, and are also illustrated in Figure 19-14.

SalSim Case	Total Adult Production by Year																Average
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
SBBASE	5,365	10,250	14,328	28,745	8,433	21,001	33,753	17,892	14,289	11,075	6,613	1,129	461	161	3,812	4,665	**11,373**
SB20%UF	5,696	10,571	14,407	25,499	8,685	19,983	30,996	16,007	14,507	11,349	6,850	1,173	680	169	4,008	5,755	**11,021**
SB30%UF	6,334	10,460	14,843	26,121	9,357	20,253	33,125	16,984	15,289	11,983	7,436	1,278	952	185	2,587	5,922	**11,444**
SB40%UF	7,213	10,484	15,170	30,888	9,872	22,289	38,824	19,996	15,801	12,613	8,072	1,392	579	216	2,594	3,611	**12,476**
SB40%MaxFS	6,843	10,540	15,474	38,226	10,704	26,833	56,691	24,875	18,557	17,604	11,252	1,332	693	194	2,499	5,870	**15,512**
SB40%OPP	7,212	11,664	14,106	31,598	10,122	25,432	36,359	20,923	16,689	13,248	8,198	1,479	489	323	2,696	6,399	**12,934**
SB50%UF	7,462	10,791	14,632	29,908	8,959	22,803	36,206	19,362	15,411	13,252	8,486	1,517	671	219	2,681	3,460	**12,239**
SB60%UF	7,229	11,162	14,441	28,770	7,473	23,601	35,632	18,404	14,633	14,258	9,158	1,575	723	204	2,834	3,677	**12,111**

The results of this SalSim evaluation indicate that improving flow conditions during the spring time period with consideration for the fall time period can produce increases in average annual total adult production from the three eastside SJR tributaries during the 1994 to 2010 modeling period. It is important to read the summary section below with respect to what the results mean during this time period. The increases in total adult production can be further improved with refined flow, reservoir storage, and temperature management as shown with the two flow shifting scenarios that were evaluated. It is expected that further refinement of flow, reservoir storage, and temperature management for the 50% and 60% cases would produce increases in total adult production that exceed those that resulted from the 40% flow cases.

19.4.4 Summary and Conclusions of the SalSim Evaluation

The use of SalSim has provided insight into what may have happened in the past if water was managed differently. It is important to understand the SalSim tool when considering what the results mean. Particularly, it is important to understand the limitations of SalSim, and it is important to understand the limitations of making optimized temperature and flow modeling runs and then inputting those flow and temperature results into SalSim.

Limitations of SalSim

All models have limitations and uncertainty. Physically based models like temperature and flow models provide a much greater lever of certainty when compared to biological models like SalSim. Modeling living organisms which have complex behaviors, and experience multi-layered ecological interactions, is a difficult task. As complicated as biological modeling is, the SalSim model appears to generally represent expected patterns. However, SalSim is inherently limited in that it does not have perfect equations (as discussed above) to explain how each environmental variable affects growth, movement, survival, and reproduction of fall-run Chinook salmon. Additionally, it is important to understand that the first 4 years of adult production are priming years, meaning that the juvenile fish from brood year 1994 do not start returning as adults until 1996, 1997, and 1998 as 2-, 3-, and 4-year-old fish, respectively. Therefore, the 1994, 1995, 1996, and 1997 adult returns do not represent a complete comparative result between baseline and the flow cases that were evaluated. Furthermore, ocean crash years which are represented in SalSim affect total adult production from 2005 to 2009 (see CDFW's Table 24 and discussion in CDFW 2014), and appear to force adult production down to approximately the same very low number regardless of the flow case. Whether this forced crash is realistic or not is unclear, because it is possible that changes to the timing, health, and abundance of smolts entering the ocean during those years could have affected how many salmon made it through that bottleneck of poor conditions. It is also possible that improved Delta outflow may have altered bay and nearshore ocean conditions in a way that improved salmon survival. Consequently, looking at a 7-year time period (1998 through 2004) to evaluate improvements to adult salmon production may be a better output instead of looking at the full 16-year SalSim time period. When this 7-year time period is evaluated, average total adult production improvements are greater (compared to the full 16-year time period) for all of the flow cases evaluated except for the SB20%UF case which makes even less fish compared to baseline. For example, the total adult production increases by 4,139 adult fish per year on average when comparing the SB40%MaxFS case to the SBBASE case for the entire 16-year period, but increases by 7,637 adult fish per year on average when comparing these cases for the 7-year period. Because this 7-year time period is so short, it becomes difficult to make inferences about what the results mean in terms of what to expect from improved flow conditions in the long term. It is likely that the increases in adult fish production during this - year modeled time period represent an increasing trend in adult production and do not represent a new long term average of expected increases in adult production into the future.

Limitation of Optimizing Modeling Runs

The program of implementation for this project allows flow shifting within the February through June time period and also allows for some shifting of water outside of this time period. As modeled, the unimpaired SED flow cases are a representation of a requirement for a certain percentage of unimpaired flow during February through June with a small amount of that water shifted to the fall. In some cases, a percentage of an unimpaired flow event for example, may not be ideal for the ecosystem. However, with flow shifting it is possible to bank water and create the full benefit of certain critical flow and temperature events. The flow shifting cases that were evaluated (SB40%MaxFS and SB40%OPP) represent some shifting and optimizing of flow, and both of these cases improved fish production compared to the non-optimized 40% case. Although these cases represent some optimization, it is likely that real-time optimization on a year-to-year, month-to-month, or day-to-day basis, as is possible with adaptive management, would provide even better results in terms of salmon production. However, optimizing flows and water temperatures in order to optimize SalSim cases, requires optimizing 16 years of flow and temperature on 3 different rivers which equates to a total of 48 years of optimization. This can include trying to time flow and temperature benefits to times and locations that match the timing and movement of fish during individual years. In a real-world management scenario, this type of real-time management can be informed by fish monitoring data like rotary screw traps and passage weirs. Optimizing long-term models on this time scale presents significant challenges; therefore rules that favor salmon on average were used to try to improve the non-optimized 40% case. In a real-world scenario, we expect using “on average” rules that are then informed and slightly modified by real-time information, will provide further improvement than what is represented by the modeling cases shown in this report.

History as a Predictor of the Future

The effectiveness of restoring the natural flow regime in a watershed was demonstrated by Kiernan et al. (2012) in lower Putah Creek where a new flow regime was implemented that mimics the seasonal timing of natural increases and decreases in streamflow. Monitoring of several sites pre- and post- implementation of the new flow regime showed a change in the distribution of the native fish community (Kiernan et al. 2012). At the onset of the study, native fishes were constrained to habitat immediately (<1 km) below the diversion dam, and non-native species were numerically dominant at all downstream sampling sites. Following implementation of the new flow regime, native fish populations expanded and regained dominance across more than 20 km of lower Putah Creek. The authors (Kiernan et al. 2012) proposed that expansion of native fishes was facilitated by creation of favorable spawning and rearing conditions (e.g., elevated springtime flows), cooler water temperatures, maintenance of lotic (flowing) conditions over the length of the creek, and displacement of alien species by naturally occurring high-discharge events.

In addition to the Putah Creek example, at least two real-world examples exist of salmon populations in the Central Valley responding substantially well to flow and non-flow restoration actions. These examples are Clear Creek and Butte Creek. Both of these tributaries to the Sacramento River underwent flow and non-flow restoration beginning in the 1990s, which resulted in dramatic population increases of Chinook salmon. On Butte Creek, the spring-run Chinook salmon estimated yearly natural adult production increased from an average of 1,018 adults per year between 1967 and 1991, to an average of 9,713 adults per year between 1992 and 2011 (USFWS 2013a). This increase in adult abundance occurred after a series of projects were implemented including small dam removals, fish ladder installations, fish screen installations, implementation of 40 cfs of dedicated instream flow from October 1 to June 30, and other flow and temperature management actions to reduce mortality to over-summering adult spring-run Chinook salmon. On Clear Creek, estimated yearly natural production of fall-run Chinook salmon increased from an average of 3,576 adults per year between 1967 and 1991, to an average of 10,685 adults per year between 1992 and 2011 (USFWS 2013a). This increase in adult abundance on Clear Creek occurred after a series of restoration actions were implemented including setting minimum instream flow and temperature targets resulting in significant flow increases throughout each year (CVPIA 2013).

Prior to European influence in California, it is estimated that adult spring-run and fall-run Chinook salmon escapement in the SJR drainage totaled in the hundreds of thousands of fish annually as an estimated lower bound (Yoshiyama et al 1998). In the Tuolumne River, fall-run Chinook salmon escapement has declined from approximately 130,000 adult salmon per year during the 1940s (Mesick 2009) to less than 500 adult salmon per year several times during the last few decades. On the Stanislaus, Tuolumne, and Merced Rivers between 1967 and 1991 (well after significant habitat modifications) there was an estimated average yearly natural production of 38,388 adult fall-run Chinook salmon that returned to spawn each year (USFWS 2013a). During the 1992 to 2011 time period there was an estimated average yearly natural production of 18,703 adult fall-run Chinook salmon that returned to spawn each year on these three rivers combined (USFWS 2013a) indicating continued declines of salmon during the last few decades.

Final SalSim Summary

With the projected temperature and floodplain benefits during the spring time period (as indicated by modeling results in the previous sections of this chapter), and with adaptive implementation, it is expected that there will be substantial increases in fall-run Chinook salmon abundance on these tributaries from unimpaired flows at or greater than 40%. The SalSim results support this expectation, and because of the apparent conservative nature of SalSim, the results are likely a lower bound of potential salmon production increases that could have occurred during the SalSim evaluation time period. Finally, it is important to consider that many other native fish and wildlife species are expected to benefit from improved flow conditions during the February through June time period including other imperiled Bay-Delta species such as steelhead, sturgeon, and splittail.

19.5 Final Discussion of Benefits Analysis

Scientific evidence indicates that reductions in flows and alterations to the flow regime in the SJR Basin, resulting from water development over the past several decades, have negatively impacted fish and wildlife beneficial uses (see Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*). The SJR Basin once supported large spring-run and fall-run (and possibly late fall-run) Chinook salmon populations; however, the basin now only supports fall-run Chinook salmon populations, and these populations are facing a high risk of extinction (Mesick 2009, 2010a, 2010b; Moyle 2002). Currently, the SJR Watershed accounts for approximately 5% of all fall-run Chinook salmon in the Central Valley, and a much smaller percentage of total salmon when winter-, spring-, and late fall-runs are included. The Stanislaus, Tuolumne, and Merced Rivers (individually or combined) have had larger reductions in the natural production of adult fall-run Chinook salmon than any of the other tributaries (or combination of three tributaries) to the Sacramento or San Joaquin Rivers when comparing the 1967-1991 and 1992-2011 time periods (USFWS 2013a). The existing low abundance and diversity of naturally spawning SJR Basin salmon and steelhead stocks increases the sensitivity of these stocks to natural disasters, long-term climate change, increasing human population, and other threats that could lead to extinction (Williamson and May 2005; Mesick 2009; Mesick 2010a; Mesick 2010b; Moyle et al. 2008; Lindley et al. 2009). One of the mechanisms of reducing extinction risk is to increase the number and distribution of viable populations within the historical range of the stocks, and to diversify population structures and life history attributes. For Central Valley fall-run Chinook salmon, Carlson and Satterthwaite (2011) suggested that the most effective means of achieving this would be to restore the SJR Basin populations.

One of the goals of the current Bay-Delta Plan update is to maintain flow conditions from the SJR Watershed to the Delta at Vernalis, sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta. The State Water Board proposes to use a percentage of unimpaired flow to restore a more natural flow regime during February through June on the Stanislaus, Tuolumne, and Merced Rivers to achieve this goal.

This chapter has presented biologically important and measurable benefits of providing higher and more variable flows during this time period using predicted effects to key evaluation, or “indicator species.” For this analysis, the indicator species used were Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*). It is anticipated that habitat benefits relative to the indicator species will also provide habitat benefits to other native fish species, including other imperiled Bay-Delta species such as sturgeon and splittail. The results of the temperature, floodplain, and SalSim analysis presented in this chapter indicate that as the percentage of unimpaired flow is increased during the February through June time period, the flow related benefits to salmon and steelhead also increase. Further, as discussed in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, there are likely to be many additional benefits (other than temperature and floodplain) that would result from improved flow conditions in these rivers. Improving flows that mimic the natural hydrographic conditions including related temperature and floodplain regimes to which native fish species are adapted, are expected to provide many juvenile salmonids with additional space, time, and food resources which are necessary for required growth, development, and survival. Extending spatial, temporal, and nutritional opportunities available to juvenile fall-run Chinook salmon and steelhead in the Stanislaus, Tuolumne, and Merced Rivers is expected to improve abundance, productivity, diversity, and spatial structure of the SJR Basin and Central Valley populations. Improving and maintaining these important population attributes should help buffer SJR Basin and Central Valley salmon and steelhead populations from catastrophic events and conditions in the future.

Although increasing flow and providing a more natural flow regime is expected to provide substantial and necessary benefits to native fishes; flow alone cannot solve the many issues that native fish populations face in the SJR Watershed. To reach the goal of achieving and maintaining viable populations of native fish, many other non-flow actions (see Program of Implementation as described in Appendix K, *Revised Water Quality Control Plan*) must be taken. For example, large scale habitat restoration should be completed. Additionally, California’s coldwater fish species require cold water, and there should be considerable effort put forth to efficiently provide cold water downstream of California's reservoirs, and to provide migratory fish access to the cold water above these reservoirs. Improved coldwater management and infrastructure will improve California's native fish populations and may save water compared to the current coldwater management and dam infrastructure.

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Attachment 1 and 2

Summarized Temperature Results and Temperature Targets and Flow Constraints Used in SalSim Optimization Run (SB40%OPP)

Chapter 19
Attachment 1

Table 19-33. Summary of mean annual temperature benefits for the Stanislaus River from different February through June unimpaired flow (UF) percentages for all water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1755	617	35%	38%	37%	43%	42%	40%
AM	Oct	64.4	1814	1473	81%	91%	90%	93%	93%	92%
R	Oct	55.4	1814	220	12%	13%	12%	13%	11%	9%
R	Nov	55.4	1755	662	38%	41%	39%	40%	38%	35%
R	Dec	55.4	1814	1741	96%	99%	99%	99%	99%	99%
R	Jan	55.4	1814	1810	100%	100%	100%	100%	100%	100%
R	Feb	55.4	1697	1530	90%	91%	91%	92%	93%	94%
R	Mar	55.4	1814	1104	61%	63%	67%	70%	75%	78%
CR	Mar	60.8	1814	1745	96%	96%	98%	99%	99%	100%
CR	Apr	60.8	1755	1585	90%	90%	92%	95%	96%	97%
CR	May	60.8	1814	1382	76%	77%	80%	82%	85%	88%
S	Apr	57.2	1755	1164	66%	67%	68%	70%	73%	76%
S	May	57.2	1814	747	41%	39%	42%	45%	52%	58%
S	Jun	57.2	1755	316	18%	18%	19%	21%	26%	29%
SR	Jun	64.4	1755	1116	64%	63%	65%	68%	73%	76%
SR	Jul	64.4	1814	529	29%	29%	32%	33%	34%	35%
SR	Aug	64.4	1814	488	27%	29%	27%	26%	25%	24%

Table 19-34. Summary of mean annual temperature benefits for the Stanislaus River from different February through June unimpaired flow (UF) percentages for dry water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1755	544	31%	32%	30%	28%	26%	23%
AM	Oct	64.4	1814	1691	93%	93%	93%	95%	94%	94%
R	Oct	55.4	1814	210	12%	12%	11%	14%	12%	7%
R	Nov	55.4	1755	841	48%	48%	48%	48%	46%	41%
R	Dec	55.4	1814	1814	100%	100%	100%	100%	100%	100%
R	Jan	55.4	1814	1814	100%	100%	100%	100%	100%	100%
R	Feb	55.4	1697	1547	91%	85%	86%	87%	89%	92%
R	Mar	55.4	1814	810	45%	31%	39%	49%	63%	72%
CR	Mar	60.8	1814	1706	94%	88%	97%	98%	100%	100%
CR	Apr	60.8	1755	1691	96%	92%	95%	96%	99%	99%
CR	May	60.8	1814	1464	81%	78%	73%	75%	84%	92%
S	Apr	57.2	1755	1053	60%	56%	56%	56%	63%	69%
S	May	57.2	1814	555	31%	29%	27%	29%	34%	38%
S	Jun	57.2	1755	147	8%	8%	8%	9%	10%	11%
SR	Jun	64.4	1755	768	44%	41%	40%	41%	47%	52%
SR	Jul	64.4	1814	322	18%	18%	17%	17%	17%	17%
SR	Aug	64.4	1814	376	21%	21%	19%	18%	18%	16%

Table 35. Summary of mean annual temperature benefits for the Stanislaus River from different February through June unimpaired flow (UF) percentages for critically dry water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1755	190	11%	17%	17%	18%	17%	16%
AM	Oct	64.4	1814	1261	70%	86%	85%	89%	88%	87%
R	Oct	55.4	1814	110	6%	6%	6%	8%	6%	5%
R	Nov	55.4	1755	420	24%	27%	24%	28%	24%	21%
R	Dec	55.4	1814	1645	91%	98%	98%	99%	99%	99%
R	Jan	55.4	1814	1814	100%	100%	100%	100%	100%	100%
R	Feb	55.4	1697	1445	85%	84%	83%	83%	85%	86%
R	Mar	55.4	1814	508	28%	26%	29%	35%	41%	46%
CR	Mar	60.8	1814	1690	93%	92%	94%	96%	98%	99%
CR	Apr	60.8	1755	1161	66%	69%	74%	82%	87%	90%
CR	May	60.8	1814	677	37%	42%	48%	54%	56%	62%
S	Apr	57.2	1755	490	28%	30%	34%	36%	39%	42%
S	May	57.2	1814	241	13%	15%	16%	19%	20%	22%
S	Jun	57.2	1755	57	3%	4%	4%	5%	4%	5%
SR	Jun	64.4	1755	427	24%	27%	30%	33%	36%	42%
SR	Jul	64.4	1814	227	12%	15%	15%	15%	14%	15%
SR	Aug	64.4	1814	186	10%	15%	15%	14%	13%	13%

Table 36. Summary of mean annual temperature benefits for the Tuolumne River from different February through June unimpaired flow (UF) percentages for all water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1605	396	25%	25%	24%	30%	30%	30%
AM	Oct	64.4	1659	1012	61%	61%	60%	64%	63%	63%
R	Oct	55.4	1659	123	7%	7%	6%	6%	5%	5%
R	Nov	55.4	1605	576	36%	36%	35%	35%	32%	31%
R	Dec	55.4	1659	1598	96%	97%	97%	96%	95%	95%
R	Jan	55.4	1659	1640	99%	99%	99%	99%	99%	99%
R	Feb	55.4	1552	1194	77%	79%	81%	83%	85%	87%
R	Mar	55.4	1659	971	59%	61%	64%	68%	72%	77%
CR	Mar	60.8	1659	1366	82%	88%	91%	95%	97%	98%
CR	Apr	60.8	1605	1193	74%	80%	86%	92%	96%	97%
CR	May	60.8	1659	967	58%	68%	81%	89%	93%	94%
S	Apr	57.2	1605	911	57%	60%	65%	71%	77%	82%
S	May	57.2	1659	675	41%	47%	55%	62%	69%	73%
S	Jun	57.2	1605	375	23%	29%	34%	37%	42%	45%
SR	Jun	64.4	1605	747	47%	62%	72%	79%	84%	86%
SR	Jul	64.4	1659	519	31%	33%	31%	37%	37%	35%
SR	Aug	64.4	1659	321	19%	19%	19%	20%	20%	19%

Table 37. Summary of mean annual temperature benefits for the Tuolumne River from different February through June unimpaired flow (UF) percentages for dry water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1605	197	12%	12%	12%	12%	12%	12%
AM	Oct	64.4	1659	1065	64%	64%	64%	64%	63%	64%
R	Oct	55.4	1659	141	8%	8%	7%	6%	5%	6%
R	Nov	55.4	1605	759	47%	46%	44%	42%	40%	42%
R	Dec	55.4	1659	1659	100%	100%	100%	100%	100%	100%
R	Jan	55.4	1659	1638	99%	99%	99%	99%	99%	99%
R	Feb	55.4	1552	1072	69%	67%	71%	75%	79%	83%
R	Mar	55.4	1659	618	37%	39%	39%	47%	57%	64%
CR	Mar	60.8	1659	1320	80%	81%	85%	94%	96%	98%
CR	Apr	60.8	1605	944	59%	67%	76%	89%	96%	99%
CR	May	60.8	1659	563	34%	55%	66%	84%	95%	98%
S	Apr	57.2	1605	534	33%	38%	48%	61%	70%	77%
S	May	57.2	1659	315	19%	28%	41%	53%	59%	65%
S	Jun	57.2	1605	69	4%	9%	15%	19%	23%	27%
SR	Jun	64.4	1605	222	14%	29%	44%	55%	68%	74%
SR	Jul	64.4	1659	148	9%	10%	11%	12%	13%	14%
SR	Aug	64.4	1659	163	10%	9%	9%	9%	9%	9%

Table 38. Summary of mean annual temperature benefits for the Tuolumne River from different February through June unimpaired flow (UF) percentages for critically dry water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1605	149	9%	10%	10%	10%	10%	10%
AM	Oct	64.4	1659	831	50%	50%	49%	53%	53%	52%
R	Oct	55.4	1659	124	8%	8%	6%	6%	4%	3%
R	Nov	55.4	1605	532	33%	34%	34%	35%	30%	25%
R	Dec	55.4	1659	1639	99%	99%	99%	99%	98%	95%
R	Jan	55.4	1659	1659	100%	100%	100%	100%	100%	99%
R	Feb	55.4	1552	928	60%	60%	61%	64%	67%	70%
R	Mar	55.4	1659	226	14%	18%	27%	34%	41%	47%
CR	Mar	60.8	1659	1022	62%	71%	79%	86%	91%	93%
CR	Apr	60.8	1605	575	36%	52%	70%	80%	88%	91%
CR	May	60.8	1659	412	25%	38%	56%	70%	77%	83%
S	Apr	57.2	1605	288	18%	26%	38%	48%	58%	67%
S	May	57.2	1659	222	13%	20%	30%	38%	44%	51%
S	Jun	57.2	1605	61	4%	9%	12%	16%	18%	20%
SR	Jun	64.4	1605	179	11%	28%	40%	49%	58%	63%
SR	Jul	64.4	1659	98	6%	7%	8%	9%	9%	10%
SR	Aug	64.4	1659	104	6%	7%	7%	7%	7%	6%

Table 39. Summary of mean annual temperature benefits for the Merced River from different February through June unimpaired flow (UF) percentages for all water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1566	210	13%	14%	13%	14%	14%	12%
AM	Oct	64.4	1618	783	48%	55%	54%	58%	57%	55%
R	Oct	55.4	1618	0	0%	0%	0%	0%	0%	0%
R	Nov	55.4	1566	192	12%	14%	13%	14%	14%	12%
R	Dec	55.4	1618	1337	83%	88%	88%	88%	87%	86%
R	Jan	55.4	1618	1522	94%	94%	94%	94%	94%	94%
R	Feb	55.4	1514	1082	71%	69%	70%	72%	73%	75%
R	Mar	55.4	1618	500	31%	30%	31%	33%	36%	42%
CR	Mar	60.8	1618	1271	79%	78%	80%	84%	87%	89%
CR	Apr	60.8	1566	610	39%	40%	53%	60%	69%	76%
CR	May	60.8	1618	380	23%	31%	41%	47%	55%	61%
S	Apr	57.2	1566	278	18%	17%	23%	25%	32%	37%
S	May	57.2	1618	190	12%	14%	17%	18%	24%	28%
S	Jun	57.2	1566	160	10%	10%	10%	10%	11%	11%
SR	Jun	64.4	1566	412	26%	33%	37%	40%	45%	49%
SR	Jul	64.4	1618	339	21%	21%	19%	20%	18%	15%
SR	Aug	64.4	1618	199	12%	12%	11%	11%	10%	9%

Table 40. Summary of mean annual temperature benefits for the Merced River from different February through June unimpaired flow (UF) percentages for dry water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1566	43	3%	3%	3%	3%	2%	2%
AM	Oct	64.4	1618	885	55%	54%	52%	51%	51%	51%
R	Oct	55.4	1618	0	0%	0%	0%	0%	0%	0%
R	Nov	55.4	1566	307	20%	20%	18%	16%	17%	17%
R	Dec	55.4	1618	1527	94%	94%	94%	94%	94%	94%
R	Jan	55.4	1618	1540	95%	95%	95%	95%	95%	95%
R	Feb	55.4	1514	849	56%	56%	56%	56%	59%	60%
R	Mar	55.4	1618	106	7%	6%	7%	9%	12%	15%
CR	Mar	60.8	1618	1128	70%	69%	73%	80%	83%	86%
CR	Apr	60.8	1566	241	15%	23%	35%	47%	61%	68%
CR	May	60.8	1618	82	5%	14%	19%	23%	30%	36%
S	Apr	57.2	1566	67	4%	6%	9%	11%	15%	16%
S	May	57.2	1618	45	3%	3%	5%	7%	8%	10%
S	Jun	57.2	1566	32	2%	2%	2%	1%	1%	1%
SR	Jun	64.4	1566	49	3%	6%	9%	13%	16%	20%
SR	Jul	64.4	1618	43	3%	3%	3%	3%	3%	3%
SR	Aug	64.4	1618	43	3%	3%	3%	3%	3%	3%

Table 41. Summary of mean annual temperature benefits for the Merced River from different February through June unimpaired flow (UF) percentages for critically dry water years.

Life Stage	Month	USEPA Criteria (°F)	Maximum Compliance Possible (Mile-Days)	Total Compliance under Baseline (Mile-Days)	% of Maximum Compliance Achieved					
					Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
AM	Sep	64.4	1566	14	1%	2%	2%	2%	2%	1%
AM	Oct	64.4	1618	534	33%	53%	53%	52%	51%	47%
R	Oct	55.4	1618	0	0%	0%	0%	0%	0%	0%
R	Nov	55.4	1566	91	6%	10%	10%	14%	13%	9%
R	Dec	55.4	1618	1207	75%	92%	91%	91%	91%	88%
R	Jan	55.4	1618	1539	95%	95%	95%	95%	95%	94%
R	Feb	55.4	1514	787	52%	48%	48%	49%	51%	53%
R	Mar	55.4	1618	93	6%	3%	4%	5%	6%	12%
CR	Mar	60.8	1618	1091	67%	62%	65%	70%	75%	79%
CR	Apr	60.8	1566	140	9%	13%	20%	27%	34%	46%
CR	May	60.8	1618	46	3%	7%	10%	14%	16%	19%
S	Apr	57.2	1566	39	3%	3%	4%	5%	7%	10%
S	May	57.2	1618	24	1%	1%	2%	3%	3%	4%
S	Jun	57.2	1566	3	0%	0%	0%	0%	0%	0%
SR	Jun	64.4	1566	39	2%	5%	7%	9%	11%	12%
SR	Jul	64.4	1618	37	2%	3%	3%	3%	2%	2%
SR	Aug	64.4	1618	22	1%	2%	2%	2%	2%	1%

Chapter 19
Attachment 2

Temperature and flow targets by water year type for the Stanislaus River temperature operation SalSim run.

Stanislaus													
Temperature Control - Wet Year					**Flow Control - Wet Year**					**surplus(+)/Deficit(-) Control Factors**			
Date	**Julian Day**	**Temp Target**	**RM**	**Selected Temp**	**Date**	**Julian Day**	**Min_Q**	**Max_Q**	**Selected flow**	**Date**	**Julian Day**	**+Q_out**	**-Q_out**
from	**from**	**F**	**(in-river)**	(0=Base, 1=Target)	**from**	**from**	**cfs**	**cfs**	**(0=Base, 1=Alt)**	**from**	**from**	**1.00=yes 0.00=No**	**1.00=yes 0.00=No**
1-Jan	1	53.60	33.30	1	1-Jan	1	400.00	800.00	1	1-Jan	1	1.00	1.00
1-Feb	32	53.60	33.30	1	1-Feb	32	400.00	800.00	1	1-Feb	32	1.00	1.00
1-Mar	60	53.60	33.30	1	1-Mar	60	800.00	1200.00	1	1-Mar	60	1.00	1.00
1-Apr	91	53.60	33.30	1	1-Apr	91	800.00	1500.00	1	1-Apr	91	1.00	1.00
1-May	121	53.60	33.30	1	1-May	121	1500.00	2500.00	1	1-May	121	1.00	1.00
1-Jun	152	53.60	33.30	1	1-Jun	152	2000.00	4000.00	1	1-Jun	152	1.00	1.00
30-Jun	181	53.60	33.30	1	30-Jun	181	2000.00	4000.00	1	30-Jun	181	1.00	1.00
1-Jul	182	64.00	45.00	1	1-Jul	182	200.00	400.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	45.00	1	10-Oct	283	200.00	400.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	33.30	1	11-Oct	284	750.00	2000.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	33.30	1	31-Oct	304	750.00	2000.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	33.30	1	1-Nov	305	400.00	1000.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	33.30	1	1-Dec	335	400.00	600.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	33.30	1	31-Dec	365	400.00	600.00	1	31-Dec	365	1.00	1.00

Stanislaus

Temperature Control - Above Normal Year

Date	Julian Day	Temp Target	RM	Selected Temp
from	from	F	(in-river)	(0=Base, 1=Target)
1-Jan	1	53.60	33.30	1
1-Feb	32	53.60	33.30	1
1-Mar	60	53.60	33.30	1
1-Apr	91	53.60	33.30	1
1-May	121	53.60	33.30	1
1-Jun	152	53.60	33.30	1
30-Jun	181	53.60	33.30	1
1-Jul	182	64.00	45.00	1
10-Oct	283	64.00	45.00	1
11-Oct	284	53.60	33.30	1
31-Oct	304	53.60	33.30	1
1-Nov	305	53.60	33.30	1
1-Dec	335	53.60	33.30	1
31-Dec	365	53.60	33.30	1

Flow Control - Above Normal Year

Date	Julian Day	Min_Q	Max_Q	Selected flow
from	from	cfs	cfs	(0=Base, 1=Alt)
1-Jan	1	400.00	600.00	1
1-Feb	32	400.00	600.00	1
1-Mar	60	600.00	1000.00	1
1-Apr	91	800.00	1250.00	1
1-May	121	1000.00	2000.00	1
1-Jun	152	1500.00	3500.00	1
30-Jun	181	1500.00	3500.00	1
1-Jul	182	200.00	400.00	1
10-Oct	283	200.00	400.00	1
11-Oct	284	500.00	1500.00	1
31-Oct	304	500.00	1500.00	1
1-Nov	305	400.00	750.00	1
1-Dec	335	400.00	600.00	1
31-Dec	365	400.00	600.00	1

surplus(+)/Deficit(-) Control Factors

Date	Julian Day	+Q_out	-Q_out
from	from	1.00=yes 0.00=No	1.00=yes 0.00=No
1-Jan	1	1.00	1.00
1-Feb	32	1.00	1.00
1-Mar	60	1.00	1.00
1-Apr	91	1.00	1.00
1-May	121	1.00	1.00
1-Jun	152	1.00	1.00
30-Jun	181	1.00	1.00
1-Jul	182	1.00	1.00
10-Oct	283	1.00	1.00
11-Oct	284	1.00	1.00
31-Oct	304	1.00	1.00
1-Nov	305	1.00	1.00
1-Dec	335	1.00	1.00
31-Dec	365	1.00	1.00

Stanislaus

Temperature Control - Below Normal Year

Date	Julian Day	Temp Target	RM	Selected Temp
from	from	F	(in-river)	(0=Base, 1=Target)
1-Jan	1	53.60	33.30	1
1-Feb	32	53.60	33.30	1
1-Mar	60	53.60	33.30	1
1-Apr	91	53.60	33.30	1
1-May	121	53.60	33.30	1
1-Jun	152	53.60	33.30	1
30-Jun	181	53.60	33.30	1
1-Jul	182	64.00	48.00	1
10-Oct	283	64.00	48.00	1
11-Oct	284	53.60	33.30	1
31-Oct	304	53.60	33.30	1
1-Nov	305	53.60	33.30	1
1-Dec	335	53.60	33.30	1
31-Dec	365	53.60	33.30	1

Flow Control - Below Normal Year

Date	Julian Day	Min_Q	Max_Q	Selected flow
from	from	cfs	cfs	(0=Base, 1=Alt)
1-Jan	1	300.00	500.00	1
1-Feb	32	300.00	500.00	1
1-Mar	60	400.00	800.00	1
1-Apr	91	600.00	1000.00	1
1-May	121	800.00	1500.00	1
1-Jun	152	1250.00	2500.00	1
30-Jun	181	1250.00	2500.00	1
1-Jul	182	200.00	300.00	1
10-Oct	283	200.00	300.00	1
11-Oct	284	500.00	1250.00	1
31-Oct	304	500.00	1250.00	1
1-Nov	305	300.00	750.00	1
1-Dec	335	300.00	500.00	1
31-Dec	365	300.00	500.00	1

surplus(+)/Deficit(-) Control Factors

Date	Julian Day	+Q_out	-Q_out
from	from	1.00=yes 0.00=No	1.00=yes 0.00=No
1-Jan	1	1.00	1.00
1-Feb	32	1.00	1.00
1-Mar	60	1.00	1.00
1-Apr	91	1.00	1.00
1-May	121	1.00	1.00
1-Jun	152	1.00	1.00
30-Jun	181	1.00	1.00
1-Jul	182	1.00	1.00
10-Oct	283	1.00	1.00
11-Oct	284	1.00	1.00
31-Oct	304	1.00	1.00
1-Nov	305	1.00	1.00
1-Dec	335	1.00	1.00
31-Dec	365	1.00	1.00

Stanislaus

Temperature Control - Dry Year

Date from	Julian Day from	Temp Target F	RM (in-river)	Selected Temp (0=Base, 1=Target)
1-Jan	1	53.60	39.40	1
1-Feb	32	53.60	39.40	1
1-Mar	60	53.60	39.40	1
1-Apr	91	53.60	39.40	1
1-May	121	53.60	39.40	1
1-Jun	152	53.60	39.40	1
30-Jun	181	53.60	39.40	1
1-Jul	182	64.00	50.60	1
10-Oct	283	64.00	50.60	1
11-Oct	284	53.60	39.40	1
31-Oct	304	53.60	39.40	1
1-Nov	305	53.60	39.40	1
1-Dec	335	53.60	39.40	1
31-Dec	365	53.60	39.40	1

Flow Control - Dry Year

Date from	Julian Day from	Min_Q cfs	Max_Q cfs	Selected flow (0=Base, 1=Alt)
1-Jan	1	200.00	400.00	1
1-Feb	32	200.00	400.00	1
1-Mar	60	400.00	600.00	1
1-Apr	91	600.00	750.00	1
1-May	121	800.00	1250.00	1
1-Jun	152	1000.00	2000.00	1
30-Jun	181	1000.00	2000.00	1
1-Jul	182	200.00	300.00	1
10-Oct	283	200.00	300.00	1
11-Oct	284	500.00	1000.00	1
31-Oct	304	500.00	1000.00	1
1-Nov	305	200.00	500.00	1
1-Dec	335	200.00	400.00	1
31-Dec	365	200.00	400.00	1

surplus(+)/Deficit(-) Control Factors

Date from	Julian Day from	+Q_out 1.00=yes 0.00=No	-Q_out 1.00=yes 0.00=No
1-Jan	1	1.00	1.00
1-Feb	32	1.00	1.00
1-Mar	60	1.00	1.00
1-Apr	91	1.00	1.00
1-May	121	1.00	1.00
1-Jun	152	1.00	1.00
30-Jun	181	1.00	1.00
1-Jul	182	1.00	1.00
10-Oct	283	1.00	1.00
11-Oct	284	1.00	1.00
31-Oct	304	1.00	1.00
1-Nov	305	1.00	1.00
1-Dec	335	1.00	1.00
31-Dec	365	1.00	1.00

Stanislaus														
Temperature Control - Critical Year					**Flow Control - Critical Year**					**surplus(+)/Deficit(-) Control Factors**				
Date	**Julian Day**	**Temp Target**	**RM**	**Selected Temp**	**Date**	**Julian Day**	**Min_Q**	**Max_Q**	**Selected flow**	**Date**	**Julian Day**	**+Q_out**	**-Q_out**	
from	**from**	**F**	**(in-river)**	**(0=Base, 1=Target)**	**from**	**from**	**cfs**	**cfs**	**(0=Base, 1=Alt)**	**from**	**from**	**1.00=yes 0.00=No**	**1.00=yes 0.00=No**	
1-Jan	1	53.60	39.40	1	1-Jan	1	200.00	400.00	1	1-Jan	1	1.00	1.00	
1-Feb	32	53.60	39.40	1	1-Feb	32	200.00	400.00	1	1-Feb	32	1.00	1.00	
1-Mar	60	53.60	39.40	1	1-Mar	60	300.00	500.00	1	1-Mar	60	1.00	1.00	
1-Apr	91	53.60	39.40	1	1-Apr	91	500.00	750.00	1	1-Apr	91	1.00	1.00	
1-May	121	53.60	39.40	1	1-May	121	750.00	1000.00	1	1-May	121	1.00	1.00	
1-Jun	152	53.60	39.40	1	1-Jun	152	750.00	1500.00	1	1-Jun	152	1.00	1.00	
30-Jun	181	53.60	39.40	1	30-Jun	181	750.00	1500.00	1	30-Jun	181	1.00	1.00	
1-Jul	182	64.00	50.60	1	1-Jul	182	200.00	300.00	1	1-Jul	182	1.00	1.00	
10-Oct	283	64.00	50.60	1	10-Oct	283	200.00	300.00	1	10-Oct	283	1.00	1.00	
11-Oct	284	53.60	39.40	1	11-Oct	284	500.00	800.00	1	11-Oct	284	1.00	1.00	
31-Oct	304	53.60	39.40	1	31-Oct	304	500.00	800.00	1	31-Oct	304	1.00	1.00	
1-Nov	305	53.60	39.40	1	1-Nov	305	200.00	500.00	1	1-Nov	305	1.00	1.00	
1-Dec	335	53.60	39.40	1	1-Dec	335	200.00	400.00	1	1-Dec	335	1.00	1.00	
31-Dec	365	53.60	39.40	1	31-Dec	365	200.00	400.00	1	31-Dec	365	1.00	1.00	

Temperature and flow targets by water year type for the Tuolumne River temperature operation SalSim run.

Tuolumne													
Temperature Control - Wet Year					**Flow Control - Wet Year**					**surplus(+)/Deficit(-) Control Factors**			
Date from	**Julian Day from**	**Temp Target F**	**RM (in-river)**	**Selected Temp (0=Base, 1=Target)**	**Date from**	**Julian Day from**	**Min_Q cfs**	**Max_Q cfs**	**Selected flow (0=Base, 1=Alt)**	**Date from**	**Julian Day from**	**+Q_out 1.00=yes 0.00=No**	**-Q_out 1.00=yes 0.00=No**
1-Jan	1	53.60	27.60	1	1-Jan	1	400.00	1000.00	1	1-Jan	1	1.00	1.00
1-Feb	32	53.60	27.60	1	1-Feb	32	400.00	1000.00	1	1-Feb	32	1.00	1.00
1-Mar	60	53.60	27.60	1	1-Mar	60	800.00	2000.00	1	1-Mar	60	1.00	1.00
1-Apr	91	53.60	27.60	1	1-Apr	91	1000.00	2500.00	1	1-Apr	91	1.00	1.00
1-May	121	53.60	27.60	1	1-May	121	2000.00	3000.00	1	1-May	121	1.00	1.00
1-Jun	152	53.60	27.60	1	1-Jun	152	2500.00	4000.00	1	1-Jun	152	1.00	1.00
30-Jun	181	53.60	27.60	1	30-Jun	181	2500.00	4000.00	1	30-Jun	181	1.00	1.00
1-Jul	182	64.00	43.60	1	1-Jul	182	400.00	600.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	43.60	1	10-Oct	283	400.00	600.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	43.60	1	11-Oct	284	500.00	2000.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	27.60	1	31-Oct	304	500.00	2000.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	27.60	1	1-Nov	305	400.00	1000.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	27.60	1	1-Dec	335	400.00	1000.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	27.60	1	31-Dec	365	400.00	1000.00	1	31-Dec	365	1.00	1.00

Tuolumne													
Temperature Control - Above Normal Year					**Flow Control - Above Normal Year**					**surplus(+)/Deficit(-) Control Factors**			
Date	**Julian Day**	**Temp Target**	**RM**	**Selected Temp**	**Date**	**Julian Day**	**Min_Q**	**Max_Q**	**Selected flow**	**Date**	**Julian Day**	**+Q_out**	**-Q_out**
from	**from**	**F**	**(in-river)**	**(0=Base, 1=Target)**	**from**	**from**	**cfs**	**cfs**	**(0=Base, 1=Alt)**	**from**	**from**	**1.00=yes 0.00=No**	**1.00=yes 0.00=No**
1-Jan	1	53.60	27.60	1	1-Jan	1	300.00	500.00	1	1-Jan	1	1.00	1.00
1-Feb	32	53.60	27.60	1	1-Feb	32	300.00	500.00	1	1-Feb	32	1.00	1.00
1-Mar	60	53.60	27.60	1	1-Mar	60	500.00	1500.00	1	1-Mar	60	1.00	1.00
1-Apr	91	53.60	27.60	1	1-Apr	91	750.00	2000.00	1	1-Apr	91	1.00	1.00
1-May	121	53.60	27.60	1	1-May	121	1500.00	2500.00	1	1-May	121	1.00	1.00
1-Jun	152	53.60	27.60	1	1-Jun	152	2000.00	3000.00	1	1-Jun	152	1.00	1.00
30-Jun	181	53.60	27.60	1	30-Jun	181	2000.00	3000.00	1	30-Jun	181	1.00	1.00
1-Jul	182	64.00	43.60	1	1-Jul	182	200.00	400.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	43.60	1	10-Oct	283	200.00	400.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	27.60	1	11-Oct	284	500.00	1750.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	27.60	1	31-Oct	304	500.00	1750.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	27.60	1	1-Nov	305	500.00	750.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	27.60	1	1-Dec	335	300.00	500.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	27.60	1	31-Dec	365	300.00	500.00	1	31-Dec	365	1.00	1.00

Tuolumne													
Temperature Control - Below Normal Year					Flow Control - Below Normal Year					surplus(+)/Deficit(-) Control Factors			
Date	Julian Day	Temp Target	RM	Selected Temp	Date	Julian Day	Min_Q	Max_Q	Selected flow	Date	Julian Day	+Q_out	-Q_out
from	from	F	(in-river)	(0=Base, 1=Target)	from	from	cfs	cfs	(0=Base, 1=Alt)	from	from	1.00=yes 0.00=No	1.00=yes 0.00=No
1-Jan	1	53.60	27.60	1	1-Jan	1	200.00	400.00	1	1-Jan	1	1.00	1.00
1-Feb	32	53.60	27.60	1	1-Feb	32	200.00	400.00	1	1-Feb	32	1.00	1.00
1-Mar	60	53.60	27.60	1	1-Mar	60	400.00	1250.00	1	1-Mar	60	1.00	1.00
1-Apr	91	53.60	27.60	1	1-Apr	91	600.00	1500.00	1	1-Apr	91	1.00	1.00
1-May	121	53.60	27.60	1	1-May	121	800.00	2000.00	1	1-May	121	1.00	1.00
1-Jun	152	53.60	27.60	1	1-Jun	152	1000.00	2500.00	1	1-Jun	152	1.00	1.00
30-Jun	181	53.60	27.60	1	30-Jun	181	1000.00	2500.00	1	30-Jun	181	1.00	1.00
1-Jul	182	64.00	43.60	1	1-Jul	182	100.00	300.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	43.60	1	10-Oct	283	100.00	300.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	27.60	1	11-Oct	284	500.00	1500.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	27.60	1	31-Oct	304	500.00	1500.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	27.60	1	1-Nov	305	200.00	500.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	27.60	1	1-Dec	335	200.00	400.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	27.60	1	31-Dec	365	200.00	400.00	1	31-Dec	365	1.00	1.00

Tuolumne

Temperature Control - Dry Year					Flow Control - Dry Year					surplus(+)/Deficit(-) Control Factors			
Date	Julian Day	Temp Target	RM	Selected Temp	Date	Julian Day	Min_Q	Max_Q	Selected flow	Date	Julian Day	+Q_out	-Q_out
from	from	F	(in-river)	(0=Base, 1=Target)	from	from	cfs	cfs	(0=Base, 1=Alt)	from	from	1.00=yes 0.00=No	1.00=yes 0.00=No
1-Jan	1	53.60	35.60	1	1-Jan	1	200.00	400.00	1	1-Jan	1	1.00	0.00
1-Feb	32	53.60	35.60	1	1-Feb	32	200.00	400.00	1	1-Feb	32	1.00	0.00
1-Mar	60	53.60	35.60	1	1-Mar	60	400.00	1000.00	1	1-Mar	60	0.00	1.00
1-Apr	91	53.60	35.60	1	1-Apr	91	600.00	1250.00	1	1-Apr	91	0.00	1.00
1-May	121	53.60	35.60	1	1-May	121	800.00	1500.00	1	1-May	121	1.00	0.00
1-Jun	152	53.60	35.60	1	1-Jun	152	1000.00	2000.00	1	1-Jun	152	1.00	0.00
30-Jun	181	53.60	35.60	1	30-Jun	181	1000.00	2000.00	1	30-Jun	181	1.00	0.00
1-Jul	182	64.00	43.60	1	1-Jul	182	100.00	300.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	43.60	1	10-Oct	283	100.00	300.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	35.60	1	11-Oct	284	500.00	1250.00	1	11-Oct	284	1.00	0.00
31-Oct	304	53.60	35.60	1	31-Oct	304	500.00	1250.00	1	31-Oct	304	1.00	0.00
1-Nov	305	53.60	35.60	1	1-Nov	305	200.00	500.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	35.60	1	1-Dec	335	200.00	400.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	35.60	1	31-Dec	365	200.00	400.00	1	31-Dec	365	1.00	1.00

Tuolumne

Temperature Control - Critical Year					Flow Control - Critical Year					surplus(+)/Deficit(-) Control Factors			
Date	Julian Day	Temp Target	RM	Selected Temp	Date	Julian Day	Min_Q	Max_Q	Selected flow	Date	Julian Day	+Q_out	-Q_out
from	from	F	(in-river)	(0=Base, 1=Target)	from	from	cfs	cfs	(0=Base, 1=Alt)	from	from	1.00=yes 0.00=No	1.00=yes 0.00=No
1-Jan	1	52.00	35.60	1	1-Jan	1	200.00	400.00	1	1-Jan	1	1.00	0.00
1-Feb	32	52.00	35.60	1	1-Feb	32	200.00	400.00	1	1-Feb	32	1.00	0.00
1-Mar	60	61.00	35.60	1	1-Mar	60	400.00	800.00	1	1-Mar	60	0.00	1.00
1-Apr	91	61.00	35.60	1	1-Apr	91	600.00	1250.00	1	1-Apr	91	0.00	1.00
1-May	121	61.00	35.60	1	1-May	121	800.00	1500.00	1	1-May	121	1.00	0.00
1-Jun	152	61.00	35.60	1	1-Jun	152	1000.00	1750.00	1	1-Jun	152	1.00	0.00
30-Jun	181	59.00	35.60	1	30-Jun	181	1000.00	1750.00	1	30-Jun	181	1.00	0.00
1-Jul	182	59.00	49.20	1	1-Jul	182	100.00	200.00	1	1-Jul	182	1.00	0.00
10-Oct	283	64.00	49.20	1	10-Oct	283	100.00	200.00	1	10-Oct	283	1.00	1.00
11-Oct	284	64.00	35.60	1	11-Oct	284	500.00	1000.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	35.60	1	31-Oct	304	500.00	1000.00	1	31-Oct	304	1.00	0.00
1-Nov	305	53.60	35.60	1	1-Nov	305	200.00	500.00	1	1-Nov	305	1.00	0.00
1-Dec	335	53.60	35.60	1	1-Dec	335	200.00	400.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	35.60	1	31-Dec	365	200.00	400.00	1	31-Dec	365	1.00	1.00

Temperature and flow targets by water year type for the Merced River temperature operation SalSim run.

Merced River													
Temperature Control - Wet Year					**Flow Control - Wet Year**					**surplus(+)/Deficit(-) Control Factors**			
Date	**Julian Day**	**Temp Target**	**RM**	**Selected Temp**	**Date**	**Julian Day**	**Min_Q**	**Max_Q**	**Selected flow**	**Date**	**Julian Day**	**+Q_out**	**-Q_out**
from	**from**	**F**	**(in-river)**	**(0=Base, 1=Target)**	**from**	**from**	**cfs**	**cfs**	**(0=Base, 1=Alt)**	**from**	**from**	**1.00=yes 0.00=No**	**1.00=yes 0.00=No**
1-Jan	1	40.00	45.00	1	1-Jan	1	400.00	800.00	1	1-Jan	1	1.00	1.00
1-Feb	32	40.00	45.00	1	1-Feb	32	400.00	800.00	1	1-Feb	32	1.00	1.00
1-Mar	60	53.60	27.07	1	1-Mar	60	800.00	1200.00	1	1-Mar	60	1.00	1.00
1-Apr	91	53.60	27.07	1	1-Apr	91	800.00	1500.00	1	1-Apr	91	1.00	1.00
-May	121	61.00	27.07	1	1-May	121	1500.00	2500.00	1	1-May	121	1.00	1.00
1-Jun	152	61.00	27.07	1	1-Jun	152	2000.00	4000.00	1	1-Jun	152	1.00	1.00
30-Jun	181	61.00	27.07	1	30-Jun	181	2000.00	4000.00	1	30-Jun	181	1.00	0.00
1-Jul	182	64.00	27.07	1	1-Jul	182	200.00	400.00	1	1-Jul	182	1.00	0.00
10-Oct	283	64.00	42.30	1	10-Oct	283	200.00	400.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	42.30	1	11-Oct	284	750.00	1500.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	27.07	1	31-Oct	304	750.00	1500.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	27.07	1	1-Nov	305	400.00	800.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	27.07	1	1-Dec	335	400.00	500.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	27.07	1	31-Dec	365	400.00	500.00	1	31-Dec	365	1.00	1.00

Merced River

Temperature Control - Above Normal Year

Date from	Julian Day from	Temp Target F	RM (in-river)	Selected Temp (0=Base, 1=Target)
1-Jan	1	40.00	45.00	1
1-Feb	32	40.00	45.00	1
1-Mar	60	53.60	42.10	1
1-Apr	91	53.60	42.10	1
1-May	121	61.00	42.10	1
1-Jun	152	61.00	42.10	1
30-Jun	181	61.00	42.10	1
1-Jul	182	64.00	46.70	1
10-Oct	283	64.00	46.70	1
11-Oct	284	53.60	42.10	1
31-Oct	304	53.60	42.10	1
1-Nov	305	53.60	42.10	1
1-Dec	335	53.60	42.10	1
31-Dec	365	53.60	42.10	1

Flow Control - Above Normal Year

Date from	Julian Day from	Min_Q cfs	Max_Q cfs	Selected flow (0=Base, 1=Alt)
1-Jan	1	200.00	400.00	1
1-Feb	32	200.00	400.00	1
1-Mar	60	600.00	1000.00	1
1-Apr	91	600.00	1250.00	1
1-May	121	1000.00	2000.00	1
1-Jun	152	1000.00	2500.00	1
30-Jun	181	1500.00	2500.00	1
1-Jul	182	100.00	300.00	1
10-Oct	283	100.00	300.00	1
11-Oct	284	750.00	1250.00	1
31-Oct	304	750.00	1250.00	1
1-Nov	305	200.00	500.00	1
1-Dec	335	200.00	400.00	1
31-Dec	365	200.00	400.00	1

surplus(+)/Deficit(-) Control Factors

Date from	Julian Day from	+Q_out 1.00=yes 0.00=No	-Q_out 1.00=yes 0.00=No
1-Jan	1	1.00	1.00
1-Feb	32	1.00	1.00
1-Mar	60	1.00	1.00
1-Apr	91	1.00	1.00
1-May	121	1.00	1.00
1-Jun	152	1.00	1.00
30-Jun	181	1.00	1.00
1-Jul	182	1.00	1.00
10-Oct	283	0.00	1.00
11-Oct	284	0.00	1.00
31-Oct	304	1.00	1.00
1-Nov	305	1.00	1.00
1-Dec	335	1.00	1.00
31-Dec	365	1.00	1.00

Merced River														
Temperature Control - Below Normal Year					Flow Control - Below Normal Year					surplus(+)/Deficit(-) Control Factors				
Date from	Julian Day from	Temp Target F	RM (in-river)	Selected Temp (0=Base, 1=Target)	Date from	Julian Day from	Min_Q cfs	Max_Q cfs	Selected flow (0=Base, 1=Alt)	Date from	Julian Day from	+Q_out 1.00=yes 0.00=No	-Q_out 1.00=yes 0.00=No
1-Jan	1	52.00	45.00	1	1-Jan	1	200.00	350.00	1	1-Jan	1	1.00	1.00
1-Feb	32	52.00	45.00	1	1-Feb	32	200.00	350.00	1	1-Feb	32	1.00	1.00
1-Mar	60	53.60	42.10	1	1-Mar	60	400.00	800.00	1	1-Mar	60	1.00	1.00
1-Apr	91	53.60	42.10	1	1-Apr	91	500.00	1000.00	1	1-Apr	91	1.00	1.00
1-May	121	61.00	42.10	1	1-May	121	750.00	1500.00	1	1-May	121	1.00	1.00
1-Jun	152	61.00	42.10	1	1-Jun	152	1000.00	2000.00	1	1-Jun	152	1.00	1.00
30-Jun	181	61.00	42.10	1	30-Jun	181	1000.00	2000.00	1	30-Jun	181	1.00	1.00
1-Jul	182	64.00	46.70	1	1-Jul	182	100.00	300.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	46.70	1	10-Oct	283	100.00	300.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	42.10	1	11-Oct	284	500.00	1000.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	42.10	1	31-Oct	304	500.00	1000.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	42.10	1	1-Nov	305	200.00	500.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	42.10	1	1-Dec	335	200.00	350.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	42.10	1	31-Dec	365	200.00	350.00	1	31-Dec	365	1.00	1.00

Merced River

Temperature Control - Dry Year					Flow Control - Dry Year					surplus(+)/Deficit(-) Control Factors			
Date	Julian Day	Temp Target	RM	Selected Temp	Date	Julian Day	Min_Q	Max_Q	Selected flow	Date	Julian Day	+Q_out	-Q_out
from	from	F	(in-river)	(0=Base, 1=Target)	from	from	cfs	cfs	(0=Base, 1=Alt)	from	from	1.00=yes 0.00=No	1.00=yes 0.00=No
1-Jan	1	52.00	45.00	1	1-Jan	1	200.00	300.00	1	1-Jan	1	1.00	1.00
1-Feb	32	52.00	45.00	1	1-Feb	32	200.00	300.00	1	1-Feb	32	1.00	1.00
1-Mar	60	56.00	42.10	1	1-Mar	60	300.00	500.00	1	1-Mar	60	1.00	1.00
1-Apr	91	56.00	42.10	1	1-Apr	91	500.00	800.00	1	1-Apr	91	1.00	1.00
1-May	121	61.00	42.10	1	1-May	121	750.00	1000.00	1	1-May	121	1.00	0.00
1-Jun	152	61.00	42.10	1	1-Jun	152	750.00	1500.00	1	1-Jun	152	1.00	0.00
30-Jun	181	61.00	42.10	1	30-Jun	181	750.00	1500.00	1	30-Jun	181	1.00	1.00
1-Jul	182	64.00	46.70	1	1-Jul	182	100.00	200.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	46.70	1	10-Oct	283	100.00	200.00	1	10-Oct	283	0.00	1.00
11-Oct	284	53.60	42.10	1	11-Oct	284	200.00	500.00	1	11-Oct	284	0.00	1.00
31-Oct	304	53.60	42.10	1	31-Oct	304	200.00	500.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	42.10	1	1-Nov	305	200.00	400.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	42.10	1	1-Dec	335	200.00	300.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	42.10	1	31-Dec	365	200.00	300.00	1	31-Dec	365	1.00	1.00

Merced River													
Temperature Control - Critical Year					Flow Control - Critical Year					surplus(+)/Deficit(-) Control Factors			
Date	Julian Day	Temp Target	RM	Selected Temp	Date	Julian Day	Min_Q	Max_Q	Selected flow	Date	Julian Day	+Q_out	-Q_out
from	from	F	(in-river)	(0=Base, 1=Target)	from	from	cfs	cfs	(0=Base, 1=Alt)	from	from	1.00=yes 0.00=No	1.00=yes 0.00=No
1-Jan	1	52.00	45.00	1	1-Jan	1	200.00	300.00	1	1-Jan	1	1.00	1.00
1-Feb	32	52.00	45.00	1	1-Feb	32	200.00	300.00	1	1-Feb	32	1.00	1.00
1-Mar	60	56.00	42.10	1	1-Mar	60	300.00	400.00	1	1-Mar	60	1.00	1.00
1-Apr	91	56.00	42.10	1	1-Apr	91	400.00	600.00	1	1-Apr	91	1.00	1.00
1-May	121	61.00	42.10	1	1-May	121	500.00	800.00	1	1-May	121	1.00	0.00
1-Jun	152	61.00	42.10	1	1-Jun	152	700.00	1000.00	1	1-Jun	152	1.00	0.00
30-Jun	181	61.00	42.10	1	30-Jun	181	700.00	1000.00	1	30-Jun	181	1.00	1.00
1-Jul	182	64.00	46.70	1	1-Jul	182	100.00	200.00	1	1-Jul	182	1.00	1.00
10-Oct	283	64.00	46.70	1	10-Oct	283	100.00	200.00	1	10-Oct	283	1.00	1.00
11-Oct	284	53.60	42.10	1	11-Oct	284	200.00	400.00	1	11-Oct	284	1.00	1.00
31-Oct	304	53.60	42.10	1	31-Oct	304	200.00	400.00	1	31-Oct	304	1.00	1.00
1-Nov	305	53.60	42.10	1	1-Nov	305	200.00	300.00	1	1-Nov	305	1.00	1.00
1-Dec	335	53.60	42.10	1	1-Dec	335	200.00	300.00	1	1-Dec	335	1.00	1.00
31-Dec	365	53.60	42.10	1	31-Dec	365	200.00	300.00	1	31-Dec	365	1.00	1.00

Chapter 20
Economic Analyses

20.1 Introduction

As described in Chapter 1, *Introduction,* the purpose of this recirculated substitute environmental document (SED) is to present the State Water Resources Control Board's (State Water Board) analysis for potential changes to the Lower San Joaquin River (LSJR) flow and southern Delta water quality (SDWQ) objectives, as well as updates to the program of implementation included in the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (2006 Bay-Delta Plan). This SED, although not an environmental impact report (EIR), fulfills the requirements of the California Environmental Quality Act (CEQA) to analyze the environmental effects of a proposed regulatory activity and its alternatives. The State Water Board must also comply with Section 13141 and Section 13241 of the Porter-Cologne Act when developing and adopting new water quality objectives.

Project-related social or economic effects are not, as a general rule, required to be analyzed in CEQA documents; however, a lead agency may decide to include an assessment of economic or social effects in an EIR (or, by extension, an SED), particularly if these effects are perceived as being important or substantial. As discussed in Section 15131 of the State CEQA Guidelines, economic or social information may be included in an EIR in whatever form a lead agency desires. The State CEQA Guidelines also indicate that social and economic issues may be discussed in an EIR when they are linked to physical change. (§ 15131, subd. (a).) The intermediate economic or social changes that cause the physical change, however, need not be analyzed in any detail greater than necessary to trace the chain of cause and effect. The focus of the analysis should be on the physical changes. If, for example, a construction project would severely limit access to a business area, and the resultant loss of taxes would reduce an agency's ability to maintain infrastructure and public services, then the fiscal (economic) impacts should be discussed. California courts have held that potential economic and social consequences of a program or project that would cause urban decay or blight (e.g., effects on downtown businesses from developing a suburban shopping center) should be discussed in an EIR (e.g., *Bakersfield Citizens for Local Control v. City of Bakersfield*).

Under the California Water Code, the need for economic analysis associated with State Water Board actions is required by two sections. Water Code Section 13141 states:

> . . . prior to implementation of any agricultural water quality control program, an estimate of the total cost of such a program, together with an identification of potential sources of financing, shall be indicated in any regional water quality control plan.

Water Code Section 13241 states that "economic considerations" should be considered in establishing water quality objectives. In practice, compliance with these statutory provisions typically involves quantifying the costs to affected parties (e.g., farmers and water districts), and assessing potential impacts on local and regional economies affected by changes in economic activity. Evaluation of other potential economic effects, such as water quality benefits, typically is conducted more qualitatively.

To address the dual objectives of the proposed plan amendments,[1] this chapter is separated into the following two geographic parts: Section 20.3, *Lower San Joaquin River and Tributaries*, and Section 20.4, *Southern Delta*.

The resources addressed in the *Lower San Joaquin River and Tributaries* section are as follows:

- 20.3.1, *Changes in Hydrologic Conditions*
- 20.3.2, *Agricultural Production and Related Effects on Economic and Local Fiscal Conditions*
- 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies*
- 20.3.4, *Effects on Hydropower Generation, Revenues and the Regional Economy*
- 20.3.5, *Effects on Fisheries and Associated Regional Economies*
- 20.3.6, *Effects on Recreational Opportunities, Activity, and the Regional Economy*

In addition to evaluating the economic effects on these resources, Section 20.3.7, *Non-Flow Measures,* identifies the costs associated with other potential compliance actions that could be taken to inform the body of scientific literature and assist with adaptive implementation.

Section 20.4, *Southern Delta*, evaluates the potential costs of complying with salinity water quality objectives in the southern Delta, consistent with requirements in Water Code Section 13241. This section presents the potential effects that higher water treatment costs could have on ratepayers and the regional economy.

The geographic locations or study areas discussed in this chapter vary by topic, depending on the resource being evaluated, the temporal and geographic distribution of that resource, and the geographic extent of potential effects on local and regional economies. As such, evaluations may extend beyond the defined plan area described in Chapter 1, *Introduction*. For example, the evaluation of recreation and commercial fisheries includes the Pacific Ocean marine waters and corresponding coastal areas. This is necessary because anadromous fish migrate to the ocean and develop there for usually 3–4 years before they can be harvested in commercial and recreational fisheries as they return to spawn in the freshwater rivers of their origin. The evaluation of recreational activities related to rivers and reservoirs is generally confined to the Stanislaus, Tuolumne, and Merced Rivers and their respective rim reservoirs, New Melones, New Don Pedro, and Lake McClure. Given the spatial variability among topics discussed in the analyses, each subsection in this chapter describes the geography in which the analysis focuses.

Several important considerations need to be noted concerning the analyses contained in this chapter. The purposes of and the analytical framework for these analyses are (1) to compare potential changes in surface water diversion-related economic effects of the LSJR alternatives, and (2) to describe the potential costs of compliance with updated water quality objectives for the southern Delta. Although the analyses conducted to address these two purposes are presented together in this chapter, this should not be interpreted as an attempt to compare relevant costs and benefits of the LSJR alternatives or of the SDWQ alternatives. While the topic-specific analyses include certain analytical components common to each discussion (e.g., evaluation of potential effects on the regional economy), the reader is strongly discouraged from trying to draw conclusions across topics concerning the overall net benefits of a particular alternative. The study areas often differ among the analyses, and information available to conduct the different analyses (such as

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[1] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

estimates of physical impacts on a corresponding resource topic) is highly variable, thereby precluding the conduct of a net benefit-type analysis.

The economic analysis presented in this SED will help inform the State Water Board's consideration of potential changes to the 2006 Bay-Delta Plan related to LSJR flow and southern Delta water quality objectives. Any project-level changes to water rights or other measures that may be needed to implement any approved updates to the 2006 Bay-Delta Plan will be considered in subsequent proceedings and would require project-level analysis, as appropriate. Therefore, the economic analyses presented in this chapter, which also summarize results from resource analyses presented elsewhere in this SED and its appendices, are limited by the programmatic nature of this document.

20.2 Summary of Results

The economic analyses in this chapter assess the potential economic effects of LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3 based on how the use of certain resources may change. The economic analyses mostly rely on impacts presented in corresponding chapters and appendices in this SED.

Under the LSJR alternatives, reductions in diversions would result both in potential cost effects (e.g., from reduced agricultural production) and potential beneficial effects (e.g., from enhanced conditions for salmon and other native fisheries) in the three eastside tributary[2] watersheds and the San Joaquin River (SJR) Basin, relative to baseline conditions. Where appropriate in this chapter, baseline conditions are described using modeled results; in cases where modeled results are not available (e.g., fisheries), historical conditions and general trends are used to establish a point of reference. As described in Chapter 3, *Alternatives Description*, baseline conditions are not representative of the No Project Alternative. The No Project Alternative represents continuation of the existing Bay-Delta Plan, with full implementation of the plan through D-1641 requirements. The anticipated economic effects of LSJR Alternatives 2, 3, and 4, which represent unimpaired flow[3] requirements of 20 percent, 40 percent, and 60 percent, respectively, on the three eastside tributaries, are summarized in Tables 20.2-1 through 20.2-5.

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[2] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[3] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

Table 20.2-1. Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, and 4, Relative to Baseline Conditions: Agricultural Production and Related Economics

	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
Category	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change
Agricultural Production						
Irrigated acreage	-6,086	-1.2	-23,421	-4.6	-70,640	-13.8
Crop revenues ($M)	-$9	-0.6	-$36	-2.5	-$117	-7.9
Additional GW pumping cost ($M)	+$1.3	+8.5	+$6.2	+40.5	+$12.7	+83.0
Local Fiscal conditions, as measured by change in tax revenue ($M)	-$0.4	-0.7	-$1.5	-2.4	-$4.7	-7.9
Regional Agriculture-Related Effects						
Total regional output ($M)	-$17	-1	-$64	-3	-$206	-8
Total regional jobs	-117	-1	-433	-2	-1,474	-8

$M = millions of dollars

GW = groundwater

Table 20.2-2. Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, and 4, Relative to Baseline Conditions: Municipal and Industrial Water Supply and Related Economics

	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
Category	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change
M&I Water Supply						
Plan Area	Change in average annual water supply due to reduced diversions would be 2% on the Stanislaus and Tuolumne Rivers and 6% on the Merced River; reduction in deliveries by irrigation and water districts would be district-specific and would depend on consideration of established water rights or contracts, types of planned uses for the water, and district (and other) policies concerning distribution of water supplies		Change in average annual water supply due to reduced diversions would be 12% on the Stanislaus, 14% on the Tuolumne River, and 16% on the Merced River; reductions in deliveries by irrigation and water districts would be district-specific, and would depend on consideration of established water rights or contracts, types of planned uses for the water, and district (and other) policies concerning distribution of water supplies. Costs would be more than under LSJR Alternative 2 because of less surface water supply		Change in average annual water supply due to reduced diversions would be 32% on the Stanislaus, 35% on the Tuolumne River, and 32% on the Merced River; reductions in deliveries by irrigation and water districts would be district-specific, and would depend on consideration of established water rights or contracts, types of planned uses for the water, and district (and other) policies concerning distribution of water supplies. Costs would be more than under LSJR Alternative 3 because of less surface water supply	
SFPUC Service Area: Additional water supply cost ($M)[a]	+$14 to +$35, depending on Fourth Agreement interpretation scenario	+2.9 to +7.2	+$27 to +$119, depending on Fourth Agreement interpretation scenario	+5.6 to +24.6	+$30 to +$208, depending on Fourth Agreement interpretation scenario	+6.2 to +43.1

Category	LSJR Alternative 2 Change from Baseline Conditions	 % Change	LSJR Alternative 3 Change from Baseline Conditions	 % Change	LSJR Alternative 4 Change from Baseline Conditions	 % Change
Regional M&I Water Supply-Related Effects						
Plan Area	Regional effects not evaluated specifically but anticipated to be relatively minor.		Regional effects not evaluated specifically but anticipated to be relatively minor.		Regional effects not evaluated specifically but anticipated to be relatively minor.	
SFPUC Service Area: Total Regional Output ($M)[a]	-$16 to -$40, depending on Fourth Agreement interpretation scenario	-0.03 to -0.06	-$31 to -$140, depending on Fourth Agreement interpretation scenario	-0.05 to -0.22	-$35 to -$244, depending on Fourth Agreement interpretation scenario	-0.05 to -0.38
SFPUC Service Area: Total Regional Jobs[a]	-117 to -292, depending on Fourth Agreement interpretation scenario	<-0.01 to -0.01	-226 to -1005, depending on Fourth Agreement interpretation scenario	<-0.01 to -0.03	-254 to -1,756, depending on Fourth Agreement interpretation scenario	<-0.01 to -0.06

M&I = municipal and industrial

SFPUC = San Francisco Public Utilities Commission

$M = millions of dollars

[a] SFPUC Service Area Water Supply Cost, Total Regional Output, and Total Regional Jobs in this table have been calculated on an annual average basis within the most severe 6-year drought period (1987–1992), rather than over the longer-term period of record. Longer-term average costs are shown in Table 20.3.3-9b, Table 20.3.3-14b, and Table 20.3.3-14b, and Table 20.3.3-15b.

Table 20.2-3. Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, and 4, Relative to Baseline Conditions: Hydropower Generation and Related Economics

	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
Category	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change
Hydropower Production						
Generation (GWh)	+29	+2	-4	0	-87	-5
Hydropower revenue ($M)	+$1.68	+2	-$0.67	-1	-$6.55	-7
Regional Hydropower-Related Effects	Regional effects not quantified but would be very minimal		Regional effects not quantified but would be minimal but greater than LSJR Alternative 2		Regional effects not quantified but would be minimal but greater than LSJR Alternative 3	

GWh = gigawatt hour

$M= millions of dollars

Table 20.2-4. Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, and 4, Relative to Baseline Conditions: Fisheries and Related Economics

	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Category	Change from Baseline Conditions	Change from Baseline Conditions	Change from Baseline Conditions
Fisheries			
Commercial and Sport Harvest	Effects cannot be quantified but would be expected to be beneficial; extent depends on program success, primarily concerning restoration of salmon populations available for harvest. During closures of the ocean commercial and sport fisheries in 2008 and 2009, the annual value of both the commercial and sport salmon fisheries in marine waters in California was estimated at between $255 and $290 million, and supported an estimated 1,823 to 2,263 jobs annually	Effects cannot be quantified but would be expected to be beneficial; extent depends on program success, primarily concerning restoration of salmon populations available for harvest. The value of the commercial and sport salmon fisheries in California marine water would be similar to that described under LSJR Alternative 2, but these effects would be more probable to occur than under LSJR Alternative 2.	Effects cannot be quantified but would be expected to be beneficial; extent depends on program success, primarily concerning restoration of salmon populations available for harvest. The value of the commercial and sport salmon fisheries in California marine water would be similar to that described under LSJR Alternative 2, but these effects would be more probable to occur than under LSJR Alternative 3.
Non-Use Values Associated with Salmon Restoration	Effects cannot be reliably quantified but would be expected to be beneficial and substantial (based on study results from the literature); extent depends on program success, primarily concerning restoration of salmon populations	Effects cannot be reliably quantified but would be expected to be beneficial and substantial (based on study results from the literature); extent depends on program success, primarily concerning restoration of salmon populations, but these effects would be more probable to occur than under LSJR Alternative 2.	Effects cannot be reliably quantified but would be expected to be beneficial and substantial (based on study results from the literature); extent depends on program success, primarily concerning restoration of salmon populations, but these effects would be more probable to occur than under LSJR Alternative 3.

Category	LSJR Alternative 2 Change from Baseline Conditions	LSJR Alternative 3 Change from Baseline Conditions	LSJR Alternative 4 Change from Baseline Conditions
Regional Fisheries-Related Effects			
Commercial & Sport	Regional effects not quantified but would be beneficial; extent depends on program success, primarily concerning restoration of salmon populations	Regional effects not quantified but would be beneficial; extent depends on program success, primarily concerning restoration of salmon populations, but these effects would be more probable to occur than under LSJR Alternative 2.	Regional effects not quantified but would be beneficial; extent depends on program success, primarily concerning restoration of salmon populations but these effects would be more probable to occur than under LSJR Alternative 3.

Table 20.2-5. Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, and 4, Relative to Baseline Conditions: Recreation Activity-Related Economics

	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
	Change from Baseline Conditions	Change from Baseline Conditions	Change from Baseline Conditions
Recreation: Tributary Rivers	Effects on river activity not quantified but expected to be generally unchanged	Effects on river activity not quantified but expected to be minor or even unchanged	Effects on river activity not quantified but expected to be minor
Recreation: Reservoirs	Effects on reservoir activity not quantified but expected to be generally unchanged	Effects on reservoir activity not quantified but expected to be minor or even unchanged	Effects on reservoir activity not quantified but expected to be minor
Regional Recreation-Related Effects	Not quantified but would be minor	Not quantified but would be minor, and slightly greater than LSJR Alternative 2	Not quantified but would be minor, and slightly greater than LSJR Alternative 3

As described in Chapter 3, *Alternatives Description*, LSJR Alternatives 2, 3, and 4 include adaptive implementation. Four different methods of adaptive implementation are analyzed under each LSJR alternative. These are described in detail in Chapter 3 (Section 3.3.3, *Adaptive Implementation*) and allow instream flow requirements under LSJR Alternatives 2, 3, and 4 to be adjusted. In general, the methods are as follows.

- Method 1, increasing or decreasing the percent of unimpaired flow required by up to 10 percent depending on the LSJR alternative selected
- Method 2, adjusting the timing of the unimpaired flow releases within the period of February–June
- Method 3, allowing some of the required unimpaired flow volume to be shifted outside of February–June, depending on the LSJR alternative selected
- Method 4, maintaining a certain base flow in the SJR at Vernalis.

The operational changes made using the adaptive implementation methods above may take place on either a short-term (e.g., monthly or annually) or a longer-term basis. Where appropriate, this chapter presents a qualitative discussion of adaptive implementation for each of the LSJR alternatives.

The SDWQ alternatives would establish a revised salinity objective to protect the beneficial uses of agriculture in the southern Delta. Revising the objective could involve costs to dischargers complying with a new National Pollution Discharge Elimination System (NPDES) discharge permit, new waste discharge requirements, or complying with a new total maximum daily load (TMDL) that is established for protecting agricultural beneficial uses. New or updated requirements would be established through subsequent actions of the Central Valley Regional Water Quality Control Board (Central Valley Water Board). Potential compliance costs would be expected mostly from increased wastewater treatment costs in various wastewater treatment districts, although costs also could be incurred by agricultural operators for return flow salinity controls. Potential ratepayer effects and regional economic effects resulting from higher treatment costs would also be possible. Because the actual methods of compliance that would ultimately be used are necessarily site- and discharge-specific, only general costs of compliance for agencies could be developed, as described below.

- **Reduce salinity discharges by developing new, higher-quality water supplies.** Based on purchases (i.e., water transfers) of substantial quantities of water in the southern Delta between 1997 and 2005, a reasonable cost for a long-term transfer would be about $310 per acre-foot (AF), whereas the purchase cost for a permanent transfer would have been about $1,716 per AF based on environmental water account (EWA) contract sales between 2002 and 2004. (Note that these are examples of unit costs ($/AF) for developing new water supplies and do not represent potential total costs if all water purveyors in the southern Delta portion of the plan area decide to develop new, higher-quality water supplies.) These cost estimates are based solely on the estimated cost of surface water and do not include capital costs (e.g., conveyance of water from source to point of use), administrative, engineering, or legal costs related to securing the water supply and building the infrastructure. Because water supply, demand, and price conditions have changed substantially since the late 1990s and early 2000s, when these unit cost estimates were developed, further research should be conducted to determine the appropriateness of these unit costs for representing current costs.

Based on examples of more recent and comprehensive cost information for relatively large-scale water supply projects, water supply costs could range from $235 to $337 million to develop between 33,600 and 45,000 AF per year (AF/y) of new surface water resources (see Table 16-24). Higher quality water would be used by water purveyors to reduce reliance on groundwater, which is typically more saline than surface water supplies.

- **Implement salinity pretreatment programs.** A wastewater treatment agency could implement a program that involves, for example, replacing 2,000 salt-regenerating water softeners over 5 years. Under such a program, the wastewater treatment agency could reasonably be expected to pay between $929,000 and $9,000,000 over the life of the program ($185,700 to $1,803,100 per year). In the case when a commercial, industrial, or institutional discharger decides to install a desalination device, costs vary based on what is being discharged, the volume, and the desired water quality entering the wastewater collection system. Costs can range considerably; relatively small systems can cost as little as $1,000 to install and $200 per year to operate, whereas larger systems can cost millions of dollars to install and tens of thousands of dollars to operate annually.
- **Develop desalination processes at the wastewater treatment plant.** Assuming a 10 million gallons per day (mgd) discharger, a wastewater treatment agency could be expected to pay between $5 million and $22 million to construct a reverse osmosis system at a wastewater treatment plant (WWTP).
- **Implement agricultural return flow salinity controls.** Control options include real-time management (e.g., changing the timing of the release of agricultural discharge to receiving waters). Assuming 11 real-time management systems to effectively cover the major water users in the plan area, estimated construction costs could total $4.7 million, with an operations and maintenance budget of $1.1 million per year (excluding costs to construct and operate temporary detention ponds).
- **Continue operating the South Delta Temporary Barriers Program.** Implementation for the SDWQ alternatives requires the continued operation (construction and removal) of the temporary barriers in the southern Delta. A recent DWR contract was awarded to build and then remove the temporary rock barriers for approximately $7.5 million, which accounts for other related construction activities but no environmental studies.
- **Provide additional low lift pumping stations at existing south Delta temporary barriers.** Assuming a two-pumping site alternative with 1,000 cubic feet per second (cfs) pumping capacity and combined pumping at Middle and Old River barriers, estimated construction costs could range from $55.5 to $540.7 million, with annual operating costs ranging from $4.5 to $62.7 million.

Under the SDWQ alternatives, costs for complying with salinity objectives could result in rate increases for ratepayers in wastewater treatment districts that do not currently meet salinity objectives set by the alternatives. Assessing how sewer utility rates could be affected by complying with salinity objectives under the SDWQ alternatives is complicated because of several uncertainties that make it infeasible to estimate rate effects as part of this SED's program-level assessment. However, the following wastewater treatment agencies could face increased compliance costs, potentially resulting in higher costs for ratepayers to offset compliance-related expenditures for development and operation of programs and/or facilities.

- No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1)— none, or the City of Tracy, City of Stockton, City of Manteca, and Mountain House Community Services District (CSD) depending on the status of NPDES permits.
- SDWQ Alternative 2: 1.0 dS/m salinity—City of Tracy, the City of Stockton, and Mountain House CSD.
- SDWQ Alternative 3: 1.4 dS/m salinity—none.

From the perspective of the regional economy in the southern Delta area, rate increases could shift a portion of the spending by residential, commercial, and industrial ratepayers from consumer goods and services, business employee wages, and business supplies and services to monthly sewer utility bills. This shift, although somewhat speculative, would not be anticipated to affect a large percentage of overall consumer and business spending in the region, but could cause relatively small reduction in sales, employment, and income in several sectors of the regional economy. To some extent, these adverse regional economic effects would be offset by increased spending by wastewater treatment agencies to construct and operate new and expanded facilities and establish and operate programs to achieve updated salinity objectives established by their NPDES permits.

20.3 Lower San Joaquin River and Tributaries

This section describes the potential economic effects of LSJR Alternatives 2, 3, and 4 based on modeling results from the State Water Board's Water Supply Effects (WSE) model and the interpretation of those results. Potential economic effects of adaptive implementation are also addressed. The LSJR alternatives represent new instream flow requirements on the eastside tributaries to the LSJR (Stanislaus, Tuolumne, and Merced Rivers) that are defined as a percent of each rivers unimpaired flow from February–June. Specific requirements of the LSJR alternatives are presented in Chapter 3, *Alternatives Description*. Changes in flows would result both in potential costs (e.g., reduction in agricultural production due to reduced diversions) and potential benefits (e.g., improved fisheries and the enhancement of river recreation opportunities); however, the analyses in this section focus on presenting the pertinent economic effects of LSJR Alternatives 2, 3, and 4 without attempting to sum values across resource topics. The dollar values reported in each subsection that follows, with the exception of certain costs reported in Section 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies*, are presented in constant 2008 dollars.

20.3.1 Changes in Hydrologic Conditions

As discussed in Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, allowable monthly diversions under LSJR Alternatives 2, 3, and 4 were estimated using the WSE model. The WSE model is a monthly water balance spreadsheet model that estimates allowable surface water diversions and reservoir operations needed to achieve the target flow requirements of LSJR Alternatives 2, 3, and 4 on the three eastside tributaries. For the purposes of this analysis, the monthly diversions were added together for a given year and presented as annual allowable diversions in thousand-acre-foot (TAF) increments. The annual diversion estimates were then used to inform the economic analysis of agricultural production effects, municipal and industrial water supply effects, hydropower generation effects, and recreation effects presented later in this chapter. The CALSIM II model run that was used as a source of information for the WSE model is the CALSIM II "Current Conditions" case used in the California Department of Water Resources (DWR) *2009 Delivery Reliability Report* (DWR 2010).

Table 20.3.1-1 summarizes how the LSJR alternatives may impact surface water diversions on the three eastside tributaries and the plan area as a whole. This table presents the average annual allowable surface water diversions under baseline conditions and the potential change of those diversions for each of the LSJR alternative, in total TAF values and as a percent of baseline diversions. Table 20.3.1-1 also includes results for adaptive implementation method 1 under each of the LSJR alternatives for illustrative purposes. Although the adaptive implementation conditions are not quantitatively analyzed for each economic resource topic addressed in this chapter, these adaptive implementation conditions are considered in assessing the likely direction and/or magnitude of impacts associated with a particular LSJR alternative.

As shown in Table 20.3.1-1, the annual average reductions in surface water diversions for the LSJR alternative without adaptive implementation ranges from 2 to 32 percent on the Stanislaus River, 2 to 35 percent on the Tuolumne River, and 6 to 32 percent on the Merced River. For the entire plan area the annual average reduction in surface water diversions for the LSJR alternatives ranges from 3 to 33 percent. In general, average annual diversions are reduced more, relative to baseline, as the unimpaired flow requirement increases (i.e., the least reduction occurs in LSJR Alternative 2 and the greatest reduction occurs in LSJR Alternative 4, both without adaptive implementation.)

The values presented in Table 20.3.1-1 are averaged over the 82-year time period of modeling results for simple reporting. However, because water supplies and related conditions in the watersheds of the Stanislaus, Tuolumne, and Merced Rivers are highly variable over time, diversion reductions could be higher or lower for a specific year than the value reported in the table, depending on the hydrologic conditions. Diversions would likely receive greater cuts in drier years, while diversions may not be reduced at all in wet years, even under LSJR Alternative 4.

Table 20.3.1-1. Average Annual Baseline Water Supply and Differences from Baseline (Changes in Diversions) in the Eastside Tributaries and Plan Area for LSJR Alternatives 2, 3, and 4 (1922–2003)

	Stanislaus (TAF)/(%)	Tuolumne (TAF)/(%)	Merced (TAF)/(%)	Plan Area (TAF)/(%)
Baseline	637/100%	851/100%	580/100%	2,068/100%
LSJR Alternative 2				
Without Adaptive Implementation	-12/-2	-20/-2	-33/-6	-65/-3
With Adaptive Implementation (30%)[a]	-33/-5	-56/-7	-60/-10	-149/-7
LSJR Alternative 3				
Without Adaptive Implementation	-79/-12	-119 /-14	-95/-16	-293/-14
With Adaptive Implementation (30%)[a]	-33/-5	-56/-7	-60/-10	-149/-7
With Adaptive Implementation (50%)[a]	-136 / -21	-193/-23	-136/ -23	-465/-23

	Stanislaus (TAF)/(%)	Tuolumne (TAF)/(%)	Merced (TAF)/(%)	Plan Area (TAF)/(%)
Baseline	637/100%	851/100%	580/100%	2,068/100%
LSJR Alternative 4				
Without Adaptive Implementation	-206/-32	-298/-35	-185/-32	-689/-33
With Adaptive Implementation (50%)[a]	-136 /-21	-193/-23	-136/-23	-465/-23

TAF = thousand acre-feet

TAF/y = thousand acre-feet per year

[a] LSJR Alternatives 2, 3, and 4 include adaptive implementation. The four methods of adaptive implementation are described in Chapter 3, *Alternatives Description*. Results are presented here for method 1, which could result in an increase or decrease of up to 10 percent of the unimpaired flow, depending on the LSJR alternative. The adaptive implementation conditions are not quantitatively analyzed for each economic resource topic addressed in this chapter; however, reference is made to these adaptive implementation conditions in assessing the likely direction and/or magnitude of impacts associated with a particular LSJR alternative.

20.3.2 Agricultural Production and Related Effects on Economic and Local Fiscal Conditions

20.3.2.1 Introduction

The analysis in this section focuses on the potential economic effects that could result from changes in agricultural production caused by reduced surface water diversions under the LSJR alternatives. The economic variables examined include agricultural production and revenues, including groundwater pumping costs, regional economic output, regional economic jobs, and local fiscal conditions. Agricultural production in the tributary watersheds is dependent on irrigation water supply from various sources, including surface water diversions, groundwater pumping, and deliveries from the State Water Project (SWP) and the federal Central Valley Project (CVP). Implementation of LSJR Alternatives 2, 3, and 4 is expected to affect the amount of allowable surface water diversions and, therefore, the agricultural production dependent on those diversions.

The study area for this evaluation includes the San Joaquin, Stanislaus, and Merced Counties (three-county region). Within the three-county region, there are multiple diverters that regularly receive surface water from the Stanislaus, Tuolumne, or Merced Rivers. The primary water providers within this area are collectively referred to as *irrigation districts* and include: South San Joaquin Irrigation District (SSJID), Oakdale Irrigation District (OID), Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD), Turlock Irrigation District (TID), Modesto Irrigation District (MID), and Merced Irrigation District (Merced ID). SEWD and CSJWCD are also sometimes referred to as *CVP contractors*. Many residents and businesses also rely on water from one of the four groundwater subbasins that underlie the three-county region: the Eastern San Joaquin, Modesto, Turlock, and Merced Subbasins[4]. Irrigation district boundaries, counties in which the districts are located, and key municipalities in this region are identified in Figures ES-2 of the *Executive Summary*, Figures 2-1a, 2-1b, and 2-4 of Chapter 2, *Water Resources*, and Figure G.1-1 of Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

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[4] As described in Chapter 9, *Groundwater Resources*, the Merced Subbasin was extended for the analysis to include a part of the Chowchilla Subbasin.

As described in Sections G.2, G.4, and G.5 in Appendix G, the analysis of agricultural production and related economic effects follows three primary steps. First, total agricultural applied water for the irrigation districts is estimated based on the allowable surface water diversions calculated by the WSE model and the available groundwater pumping capacities of the irrigation districts. Second, the Statewide Agricultural Production (SWAP) model is used to estimate how changes in applied water directly affect agricultural production and associated revenues. Finally, the Impact Analysis for Planning (IMPLAN) input-output model is used to estimate how changes in agricultural production revenues, predicted by SWAP for the study area, could impact regional economic output and jobs. The IMPLAN analysis considers the effects on all interconnected sectors of the regional economy to estimate the total economic effect, including direct, indirect, and induced effects.

If surface water supplies are reduced, diverters would likely increase groundwater pumping to help mitigate shortage and to meet their demands. Therefore, implementation of LSJR Alternatives 2, 3, and 4 also would be expected to affect the need for and costs of additional groundwater pumping by farm operators. Appendix G describes the groundwater pumping calculations in section G.2.1, *Inputs from the WSE Model*, and G.2.2, *Methodology for Calculating Applied Water*, and summarizes the groundwater pumping results in Tables G.3-3 and G.4-11. Potential economic impacts related to the costs of additional groundwater pumping are summarized below.

This section focuses on three related topics: agricultural production and revenues, including the potential impacts of additional groundwater pumping on farm operators, regional economic effects (total economic output and jobs) in the study area, and effects on local fiscal conditions. For each topic, the modeled baseline conditions are compared to modeled results for LSJR Alternatives 2, 3, and 4 to determine the economic effects.

Baseline Agricultural Production and Revenues and Potential Farmer Effects

Assessment Methods

This section describes application of the SWAP model, including a description of the model inputs. The SWAP model is a widely used agricultural production model for estimating the response of agricultural production and associated revenues to changes in water supply. SWAP uses estimates of applied water (described in Appendix G, Section G.2.4, *Estimates of Total Applied Water*) along with crop distribution information (described in Appendix G, Section G.4.2, *Crop Distribution and Applied Water for SWAP*) to estimate agricultural production and associated revenues under baseline conditions and for LSJR Alternatives 2, 3, and 4. For more detailed description of the SWAP model, see Appendix G, Section G.4.1, *Description of the Statewide Agricultural Production Model.*

The SWAP model optimizes available land and water such that net returns to farmers are maximized. As water becomes more scarce, the crops most affected, in general, are Pasture, Alfalfa, Rice, and Other Field Crops. These crops are affected more because they require relatively high water use and/or generate lower net revenue per acre when compared to annual crops, such as Almonds and Pistachios. In this analysis, the lower net-revenue crops cover large portions of the study area; consequently, the acreages of these crop groups are substantially reduced as a result of the LSJR alternatives, particularly for LSJR Alternative 4.

Agricultural Production and Revenues

Table 20.3.2-1 presents the average annual acreage of irrigated crops under baseline conditions and the average difference (in acres and percent) between LSJR Alternatives 2, 3, and 4 and these baseline conditions, by crop group. As shown, total acreage is reduced by about 6,100 acres (1.2 percent) under LSJR Alternative 2, by about 23,700 acres (4.6 percent) under LSJR Alternative 3, and by about 70,600 acres (13.8 percent) under LSJR Alternative 4.

Table 20.3.2-1. Average Annual Acreage of Irrigated Crops for Baseline and Average Difference (in Acres and Percent) between LSJR Alternatives 2, 3, and 4 and Baseline, by Crop Group

	Baseline	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
Crop Group	Acreage	Change	% Change	Change	% Change	Change	% Change
Alfalfa	33,311	-716	11.8	-4,584	19.4	-10,528	14.9
Almonds/Pistachios	115,054	-151	2.5	-528	2.2	-1,588	2.2
Corn	107,051	-1,194	19.6	-3,332	14.1	-18,798	26.6
Cotton	2,482	0	0.0	-11	0.0	-38	0.1
Cucurbits	2,652	-29	0.5	-64	0.3	-230	0.3
Dry Bean	2,475	-55	0.9	-149	0.6	-610	0.9
Grain	14,226	-24	0.4	-79	0.3	-409	0.6
Onion and Garlic	781	-1	0.0	-2	0.0	-5	0.0
Orchards	77,773	-59	1.0	-202	0.9	-602	0.9
Other Field Crops	53,438	-2,430	39.9	-7,345	31.0	-20,137	28.5
Other Truck Crops	27,883	-103	1.7	-358	1.5	-1,896	2.7
Pasture	31,680	-1,024	16.8	-6,148	26.0	-13,353	18.9
Rice	6,067	-246	4.0	-708	3.0	-1,973	2.8
Safflower	158	-9	0.1	-23	0.1	-64	0.1
Subtropical	1,985	-7	0.1	-25	0.1	-56	0.1
Sugarbeet	277	0	0.0	-1	0.0	-2	0.0
Tomato (fresh)	10,360	-2	0.0	-6	0.0	-20	0.0
Tomato (processing)	1,828	-23	0.4	-67	0.3	-190	0.3
Vine	22,749	-13	0.2	-47	0.2	-141	0.2
TOTAL	512,229	-6,086	-1.2	-23,679	-4.6	-70,640	-13.8

Source: Derived from Appendix G, Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results, Table G.4-6a to Table G.4-6f.

Note: SWAP results presented in this table assume groundwater pumping similar to what occurred in 2009. If groundwater pumping capacity for 2014 is used instead, the results show an overall decrease in the reduction of average annual crop acreage within all irrigation districts, but particularly MID. See Appendix G for more information related to 2009 versus 2014 groundwater pumping information.

As discussed in Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* the SWAP modeling predicts that pasture and field crops could be nearly eliminated from production in some years of extreme drought, particularly under LSJR Alternatives 3 and 4. On the other hand, higher-value crops, such as Vines, remain unaffected under LSJR Alternatives 2 and 3. The modeling results predict that higher-value crops, such as Tomatoes, are less affected by reduced surface water diversion than lower-value crops because farmers would be expected to fallow lower-value crops first. Perennial crops such as Vines, Almonds, Pistachios, and Sub-Tropical crop groups, are predicted to experience decreases in production only during prolonged extreme droughts, such as occurred in the early 1990s.

Similar to changes in crop acreages, when compared to baseline conditions, average annual crop revenues generated across all irrigation districts are predicted to slightly decrease under LSJR Alternative 2 and to decline more substantially as irrigation water becomes less available under LSJR Alternatives 3 and 4. As shown in Table 20.3.2-2, total average annual crop revenues in the entire region would decrease by an estimated $9 million, or about 0.3 percent, under LSJR Alternative 2, as compared to baseline revenues. Under LSJR Alternatives 3 and 4, crop production revenues are estimated to decline by $36 million (2.4 percent) and $117 million (7.9 percent), respectively, as compared to baseline revenues.

Table 20.3.2-2. Estimates of Annual Average Agricultural Revenues under Baseline Conditions and the Change in Revenues for LSJR Alternatives 2, 3, and 4, by Irrigation District

		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
	Baseline	Difference from Baseline		Difference from Baseline		Difference from Baseline	
Irrigation District	$Million/y, 2008	$Million/y, 2008	% Change	$Million/y, 2008	% Change	$ Million/y, 2008	% Change
SSJID	229	-2	-1.0	-6	-2.6	-19	-8.1
OID	129	-2	-1.4	-5	-3.9	-14	-11.1
SEWD/CSJWCD	334	0	0.0	0	0.0	0	0.0
MID	148	-2	-1.2	-7	-5.0	-29	-19.5
TID	341	-3	-1.0	-16	-4.8	-50	-14.7
Merced ID	296	0	<1.0	-2	<1.0	-5	-1.7
TOTAL	1,477	-9	<1.0	-36	-2.4	-117	-7.9

Source: Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* Table G.4-9.

Because water supplies and other conditions important to agricultural production are highly variable over time, effects associated with LSJR Alternatives 2, 3, and 4 on crop revenues also vary. These trends are characterized in Appendix G (Figure G.4-1) by an exceedance plot that shows the magnitude and variability of estimated revenues across the 82 years of model simulation (1922–2003) for LSJR Alternatives 2, 3, and 4 and baseline.

Groundwater Pumping Costs and Potential Impacts on Farmers

As discussed in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, additional groundwater pumping needed to offset the loss of surface water supplies could affect the profitability of farming operations. These potential impacts, which are discussed in detail in Appendix G, are summarized below.

Factors affecting the costs of drilling and operating new groundwater wells, or to increase the production of existing wells, include pump efficiency, depth of the well, cost of electricity, volumetric flow, cost of materials for maintenance (lubrication, replacement parts, etc.), proximity to water distribution system, and the staff needed to maintain equipment and facilities. For this analysis, an average energy price of $0.189/kilowatt hour (kWh) over the entire irrigation season was assumed based on information contained in the SWAP model (CH2M Hill 2012). The cost effects of additional groundwater pumping on farming operations are presented in Table 20.3.2-3. The average price used for this analysis is considered a conservative assumption because some of the affected irrigation districts have hydropower projects and/or receive discounted power that would be less expensive than this average price,

The estimated increase in groundwater pumping costs would range from $1.3 million per year under LSJR Alternative 2 to $12.7 million per year under LSJR Alternative 4, when compared to baseline conditions (Table 20.3.2-3). In addition to estimating the cost of additional groundwater pumping on farming operations, an IMPLAN-based analysis of the induced effects on proprietary income (presented in Table 20.3.2-3 as Induced Economic Impact) from additional groundwater pumping are estimated to range from about $1 million per year (LSJR Alternative 2) to about $9.8 million per year (LSJR Alternative 4). Loss in proprietor income also may result in some reductions in employment in the study area, ranging from 7 jobs in in LSJR Alternative 2 to about 74 per year in LSJR Alternative 4, when compared to baseline conditions.

One of the effects of increased pumping costs would be to transfer income from farming to mostly power utilities. Because operations of the power utility entities that serve the area are mostly located outside the plan area, most of the benefits in employment and economic output from this transfer would be expected to occur outside the study area.

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood to change economic effects as it would allow the unimpaired flow requirement to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow). For LSJR Alternative 2 an increase from 20 percent to 30 percent of the unimpaired flow would likely result in different effects as compared to those shown above for LSJR Alternative 2, depending upon flow conditions and frequency of the adjustment. As such, under LSJR Alternatives 2 or 3, if the percentage of unimpaired flow is increased with adaptive implementation method 1, crop production would likely shift more toward higher-value crops and away from lower value crops (e.g., Pasture, Row Crops) than is predicted without adaptive implementation. On the other hand, under LSJR Alternatives 3 and 4, if the percent of unimpaired flow is reduced with adaptive implementation method 1, the shift toward higher value crops would not be as great and revenue losses for lower value crops would be smaller than those predicted without adaptive implementation.

Baseline Regional Economic Conditions and Potential Regional Effects

This section addresses potential regional economic effects associated with changes in agricultural production and revenues. Estimates of the total economic output and total employment within the three-county region under baseline conditions and under LSJR Alternatives 2, 3, and 4 are presented. As discussed in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, IMPLAN-derived multipliers were applied to the estimated changes in crop production revenues as predicted by SWAP to determine these effects.

Table 20.3.2-3. The Average Annual Cost of Groundwater Pumping in the Irrigation Districts, and its Associated Induced Effects on Total Economic Output and Employment under Baseline Conditions and for LSJR Alternatives 2, 3, and 4

			Change from Baseline		
		Baseline[a]	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Average Annual GW Pumping	TAF/y	258	21	104	216
Average Annual Cost of GW Pumping	$Millions/y, 2008	15.3	1.3	6.2	12.7
Induced Economic Effect	$ Millions/y, 2008	11.9	1.0	4.8	9.8
Induced Employment Effect	Jobs/y	89	7	36	74

Source: Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* Table G.4-11.

GW = groundwater

TAF/y = thousand acre-feet per year

[a] The baseline induced effects are approximated using marginal impact multipliers, so these values likely differ to some extent from the actual values.

Assessment Methods

To estimate the regional economic effects of agricultural production under baseline conditions and for LSJR Alternatives 2, 3, and 4, this assessment used multipliers developed from the 2010 IMPLAN database. The IMPLAN model relies on a snapshot of the interrelationships among sectors and institutions in a regional economy; it is widely used to assess the regional economic effects resulting from changes in the availability and use of resources.

For the IMPLAN analysis, direct agricultural revenues from the SWAP model, described above, were "mapped" from the SWAP categories to different IMPLAN crop groups. The economic effect of each LSJR alternative was then estimated in terms of the total annual economic output less estimates of the direct annual revenues under baseline conditions. As described in Appendix G, the majority of the irrigation district areas modeled using IMPLAN is contained within San Joaquin, Merced, and Stanislaus Counties.

Potential effects on economic activity can extend beyond the three-county region used to analyze predicted changes in agricultural production. These changes could affect residents and businesses throughout the state, and beyond. In general, even when a change in agricultural production occurs in a particular region, change in economic activity (sales and purchases) typically extends beyond that area, both directly and indirectly. For example, agricultural inputs, such as seed, fertilizer, insurance services, and fuel and transportation, often originate outside the region where they are used. After accounting for direct sales and purchases, the indirect and induced transactions that result from income changes and secondary effects broaden the boundaries of the originally-affected area.

These potential effects outside of the three-county region, however, are not quantified for this analysis; the analysis focuses on the three-county region where the irrigation districts are located and where the direct effects on agricultural production and associated revenues would occur. Effects on areas outside of this region would be more dispersed, thereby incurring an increasingly smaller effect.

Results

Overview of Regional Economic Effects

Under LSJR Alternatives 2, 3, and 4, reductions in water deliveries to agricultural users would affect several sectors of the economy, in addition to agriculture. When farm production decreases as a result of reduced water availability, farmers often would hire fewer seasonal workers and may lay off some year-round workers. Without jobs, household spending by these workers is likely to decrease, affecting retailers and other businesses in the area. In addition, farmers would likely reduce purchases of equipment, materials, and services from local businesses, reducing jobs and income for these suppliers. The total regional economic effect is the sum of the direct effects on agriculture and the associated indirect and induced effects.

Effects on Total Economic Output in the Study Area

Table 20.3.2-4, presents estimates of average annual effects on total economic output (including direct, indirect, and induced effects) related to agricultural production in the irrigation districts under baseline conditions. Table 20.3.2-4 also presents differences from baseline conditions, both in dollars and as a percent, for each LSJR alternative. The table splits the total sector output into direct effects and indirect and induced effects. As shown, as the unimpaired flow for an LSJR alternative increases, the effect on economic output also increases.

Table 20.3.2-4. Estimates of Total Economic Output Related to Agricultural Production in the Irrigation Districts under Baseline Conditions and Associated with Changes in Agricultural Production under LSJR Alternatives 2, 3, and 4

Economic Output Effects	Baseline Total Economic Output ($ Millions, 2008)[a]	Change from Baseline ($ Millions, 2008)		
		LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Direct Economic Output	1,477	-9	-36	-117
Indirect and Induced Economic Output	1,109	-7	-27	-89
Total Economic Output	2,586	-17	-64	-206
% of Baseline Total Economic Output	100	-0.6	-2.5	-8.0

Source: Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, Table G-5.4.

[a] The baseline economic output is approximated using marginal impact multipliers, so these values likely differ to some extent from the actual values.

Effects on Total Employment in the Study Area

Table 20.3.2-5 presents estimates of the number of jobs associated with crop production and affected economic activity in other sectors of the economy under baseline conditions. The table also presents differences from baseline conditions, both in total jobs and as a percent, for each LSJR alternative.

The total effect on jobs associated with the LSJR alternatives are relatively similar to the effects on economic output. The number of jobs within the crop production sector (direct effects) and those within other affected sectors (indirect and induced) are presented.

Table 20.3.2-5. Estimates of Total Employment Related to Agricultural Production in the Irrigation Districts under Baseline Conditions and the Change for LSJR Alternatives 2, 3, and 4

Employment Effects	Baseline Total Employment (# of Jobs)[a]	Change from Baseline (# of Jobs)		
		LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Direct Employment	8,087	-53	-190	-692
Indirect and Induced Employment	10,514	-64	-242	-782
Total Employment	18,601	-117	-433	-1474
% of Baseline Total Employment	100	-0.6	-2.3	-7.9

Source: Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, Table G-5.6.

[a] The baseline employment is approximated using marginal impact multipliers, so these values likely differ to some extent from the actual values.

Other Regional Considerations

As described in Appendix L, *City and County of San Francisco Analyses*, and summarized in Section 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies*, the analysis of potential economic effects on water districts and ratepayers in the San Francisco Public Utilities Commission (SFPUC) service area assumes that water districts and farm operators in the plan area would be willing to sell water to the SFPUC for $1,000 per AF and that existing Tuolumne River water supply infrastructure would be used to transfer this water to the San Francisco Bay Area. These assumed agreements would result in a stream of income from the SFPUC to the willing irrigation districts. As shown in Tables 20.3.3-9a and 20.3.3-9b (Section 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies*), the income that would be paid in severe drought years to the irrigation districts is estimated to be $14 million or $25 million under LSJR Alternative 2, $27 million or $119 million under LSJR Alternative 3, and $30 million or $208 million under LSJR Alternative 4, depending on which scenario under the Fourth Agreement between CCSF and the irrigation districts is agreed upon. (For more information regarding the Fourth Agreement, see Section 20.3.3.4, *M&I Water Supply Conditions in the SFPUC Service Area and Potential Effects*.) This income would be expected to offset, to some extent, the economic effects in the three-county region caused by reduced agricultural production.

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood of changing economic effects as it would allow the unimpaired flow requirements to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow). For LSJR Alternative 2, an increase from 20 percent to 30 percent of the unimpaired flow would likely result in different effects as compared to those shown above for LSJR Alternative 2, depending upon flow conditions and frequency of the adjustment. As such, under LSJR Alternatives 2 or 3, if the percentage of unimpaired flow is increased with adaptive implementation method 1, the regional economic and employment effects could be greater than those predicted without adaptive implementation. On the other hand, under LSJR Alternatives 3 and 4, if the percent of unimpaired flow is reduced with adaptive implementation method 1, the regional economic and employment effects could be less than those predicted without adaptive implementation.

Baseline Local Fiscal Conditions and Potential Fiscal Effects

This section describes how changes in agricultural production could affect local fiscal conditions in the three-county study region. Agricultural production encourages economic activity throughout local economies, generating millions of dollars in revenue for farmers and related industries. Federal, state, and local governments also collect a portion of this income by imposing various taxes. Potential fiscal effects at the state and federal level are described in Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, along with details of the following assessment on local fiscal conditions.

Overview

Because the amount of tax revenue generated by a community depends on its levels of economic activity, reductions in agricultural production may have fiscal impacts on tax revenue for cities, counties, the state, and the federal government. There could be direct impacts on sales tax revenue associated with the reduction in agricultural production because there is less crop product to sell. Property taxes may decrease slightly as property values decline from fallowing of farmland and reduced economic activity in the area. Tax revenue generated from other industries also could decrease in response to the indirect and induced effects caused by changes in crop production. A significant decline in tax revenue from reduced agricultural production could in turn impact the delivery of public services. Although vital services, such as health and safety, would likely maintain funding by tapping into other available sources of revenue, less critical services, such as public transportation and road systems, could be forced to operate with smaller budgets.

Table 20.3.2-6 presents estimates of total tax revenue received by local governments for each county within the three-county region during 2010, and the contribution of crop farming related production and import tax revenues to each county's total. Taxes on production and imports represent sales tax, property tax, and other miscellaneous taxes (severance, motor vehicle license); it does not include income or corporate taxes, which primarily go to the state and federal governments. Of the three counties in the study area, the agricultural sector makes the greatest percent contribution in Merced County where it generates about 4.5 percent of the tax revenue. Overall, San Joaquin and Stanislaus Counties receive more tax revenue than Merced County, primarily because they have larger urban populations, but agriculture contributes a smaller percent of the total tax revenue.

Table 20.3.2-6. Estimates of Local Government Tax Revenue and Crop Farming Contribution from IMPLAN

	Total Annual Tax Revenue to Local Governments[a]	Total Annual Tax Revenue from Crop Farming to Local Governments[b]	Crop Farming Contribution as % of Total Tax Revenue
County	($ Millions, 2010)	($ Millions, 2010)	(%)
San Joaquin	983	18	1.9
Stanislaus	736	11	1.4
Merced	283	13	4.5

Source: Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, Table G-5.9.

$ Million, 2010 = millions of 2010 dollars.

[a] Local government includes the governments of both the county and cities within the county.

[b] Only includes taxes on production and imports, not personal taxes.

Assessment Methods

Multipliers derived from the IMPLAN input-output model are used to estimate potential local tax revenue effects under LSJR Alternatives 2, 3, and 4. These multipliers are developed for a three-county study region of San Joaquin, Stanislaus, and Merced Counties, and also for each of the three counties individually. Table 20.3.2-7 presents the impact and the fiscal impact multipliers associated with an agricultural revenue loss of $1 million in each county. For example, a 1 million dollar loss in agricultural revenue in San Joaquin County would have a direct loss of $15,691 in tax revenue for local governments. Accounting for the indirect and induced effects of the 1 million dollar loss would increase the tax revenue losses to $44,731. To create fiscal impact multipliers for the different levels of government, the total loss at each level of government is divided by $1 million. In other words, the total federal tax impact is 15.4 percent of the agricultural revenue loss, the total state tax impact is 6.1 percent of the loss, and the total local tax impact is 4.5 percent of the loss.

The county fiscal impact multipliers in Table 20.3.2-7 are used with the SWAP results for crop revenue as described in Appendix G, Section G.4.3, *SWAP Modeling Results,* to estimate the tax revenue losses. Before applying the multipliers, SWAP results for crop revenue in each of the irrigation districts are first totaled by county. For OID and TID, which each overlap portions of two counties, the revenue is divided between the counties based on the relative area of the irrigation districts in each county. According the OID AWMP (2012) 20 percent of OID falls in San Joaquin County and 80 percent falls in Stanislaus County. TID is estimated to have 74 percent of its area in Stanislaus County and 26 percent of it area in Merced County, based on GIS analysis.

Table 20.3.2-7. Fiscal Impacts by County of a Hypothetical $1 Million Crop Revenue Loss

Level of Government	Tax Revenue Impact ($ Million, 2010)		Fiscal Impact Multipliers	
	Direct	Total[a]	Direct	Total
San Joaquin				
Federal	-75,482	-154,003	0.075	0.154
State	-27,156	-61,415	0.027	0.061
Local	-15,691	-44,731	0.016	0.045
Stanislaus				
Federal	-83,268	-153,658	0.083	0.154
State	-28,707	-60,647	0.029	0.061
Local	-15,998	-40,519	0.016	0.041
Merced				
Federal	-70,966	-108,684	0.071	0.109
State	-26,757	-47,082	0.027	0.047
Local	-15,404	-32,610	0.015	0.033

Source: Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* Table G-5.12.

$ Million, 2010 = millions of 2010 dollars.

[a] Includes direct, indirect, and induced effects of a $1 million (in 2010 dollars) loss in agricultural revenue.

Results

This section focuses on potential effects for local tax revenues under each of the LSJR alternatives, although results for state and federal tax revenues also are addressed. Table 20.3.2-8 shows the annual average tax revenue related to changes (decreases) in agricultural production for each level of government in the three counties individually and in the three-county region as a whole. Under baseline, the federal government receives about $210 million and the state receives about $85 million in tax revenue from agricultural production over all three counties, which is only 0.01

percent and 0.09 percent of their total tax revenue for 2010, respectively. Both federal and state tax revenues from agricultural production in the three counties decrease by an estimated 0.7 percent under LSJR Alternative 2, up to about 8.1 percent under LSJR Alternative 4; however, these changes are minor compared to the total revenue for 2010.

Table 20.3.2-8. Estimated Change in Tax Revenue Associated with Predicted Changes in Annual Agricultural Production for LSJR Alternatives 2, 3, and 4 Relative to Baseline Conditions

		Tax Revenue Effects of Agricultural Production			
		Baseline ($ Millions, 2008)[a]	Change Relative to Baseline ($ Millions, 2008)		
County	Level of Government		LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
San Joaquin	Federal	91	-0.41	-1.08	-3.29
	State	36	-0.16	-0.43	-1.31
	Local	26	-0.12	-0.31	-0.96
Stanislaus	Federal	77	-0.89	-3.60	-11.88
	State	31	-0.35	-1.42	-4.69
	Local	20	-0.23	-0.95	-3.13
Merced	Federal	42	-0.12	-0.63	-1.98
	State	18	-0.05	-0.27	-0.86
	Local	13	-0.03	-0.19	-0.59
Total, All Counties	Federal	210	-1.41	-5.31	-17.15
	State	85	-0.56	-2.12	-6.86
	Local	59	-0.39	-1.45	-4.68

Source: Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* Table G-5.13.

$ Millions, 2008 = millions of 2008 dollars.

[a] The baseline tax revenue is approximated using marginal impact multipliers, so these values likely differ to some extent from the actual values.

Table 20.3.2-9 summarizes the effect of the LSJR alternatives on local governments and how it compares to the total annual tax revenue from Table 20.3.2-6. Under baseline, local governments in San Joaquin, Stanislaus, and Merced Counties receive an estimated $26, $20, and $13 million in tax revenue from annual agricultural production, respectively. These revenues represent about 2.7 to 4.5 percent of the total annual tax revenue for local governments in each of the three counties (Table 20.3.2-9). For the LSJR alternatives, the resulting impact on tax revenue is small compared to the total annual tax revenue. Stanislaus County has the largest reduction in tax revenue of the three counties, but its losses would not exceed an estimated 0.4 percent of the total annual tax revenue under any of the LSJR alternatives.

Table 20.3.2-9. Estimates of Local Tax Revenue Associated with Predicted Changes in Annual Agricultural Production, as a Percent of Total Tax Revenue

County	Estimates of Total Annual Tax Revenue to Local Governments[a,b] ($ Millions, 2008)	Tax Revenue Related to Predicted Annual Agricultural Production, by County: Baseline Value as % of Estimated Total Annual Tax Revenue[c]	Change Relative to Baseline as % of Estimated Total Annual Tax Revenue: LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
San Joaquin	963	2.7	<0.01	<0.01	-0.1
Stanislaus	722	2.8	<0.01	-0.1	-0.4
Merced	278	4.5	<0.01	-0.1	-0.2

Source: Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* Table G-5.14.

$ Million, 2008 = millions of 2008 dollars.

[a] Local government includes the governments of both the county and cities within the county.

[b] Dollar values from IMPLAN are in $2010 and had to be converted to $2008 with a conversion factor of 0.980 derived from BEA data (BEA 2016).

[c] The baseline tax revenue is approximated using marginal impact multipliers, so these values likely differ to some extent from the actual values.

Given the results presented above (and in Appendix G), LSJR Alternatives 2, 3, and 4 would have a minor effect on tax revenue for all levels of government relative to the total tax revenue collected by each level of government. Tax revenue from agricultural production is a larger percentage of income for local governments than for the federal or state government, but it is still relatively small compared to tax revenue from other sources. Although the three counties in the study area account for some of the largest agricultural producing counties in the state[5], the contribution to tax revenue from agriculture is relatively small for most local governments. A recent report similarly concluded that lost agricultural production over the drought from 2012–2014 did not substantially impact the finances of most local governments (MIS 2014). While there could be localized impacts on small towns that primarily rely on agriculture, most cities within the three-county region would not be expected to experience substantial budgetary changes or impacts on public services.

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood of changing fiscal effects as it would allow the unimpaired flow requirements to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow). For LSJR Alternative 2, an increase from 20 percent to 30 percent of the unimpaired flow would likely result in different effects as compared to those shown above for LSJR Alternative 2, depending

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[5] See information in the 2012 Census of Agriculture for California – county data. Can be accessed at: https://www.nass.usda.gov/Statistics_by_State/California/Publications/

upon flow conditions and frequency of the adjustment. As such, under LSJR Alternatives 2 or 3, if the percentage of unimpaired flow is increased with adaptive implementation method 1, tax revenue related to agricultural production would likely decrease slightly more than is predicted without adaptive implementation. On the other hand, under LSJR Alternatives 3 and 4, if the percent of unimpaired flow is reduced with adaptive implementation method 1, tax revenue related to agricultural production would be slightly larger than predicted without adaptive implementation. Overall, given the very small estimated changes in agricultural-related tax revenue, it is not expected that adaptive implementation would substantially change the effects presented above.

20.3.3 Effects on Municipal and Industrial Water Supplies and Affected Regional Economies

Implementation of LSJR Alternatives 2, 3, and 4 could result in surface and groundwater water supply reductions to municipal and industrial (M&I) service providers in the plan area, as described in Chapter 13, *Service Providers*, and Chapter 22*, Integrated Discussion of Potential Municipal and Domestic Water Supply Management Options*. Specifically, M&I service providers that rely on surface water contracts with irrigation districts within the plan area or rely solely on groundwater from the four primary groundwater subbasins under the plan area could be particularly affected if they do not have ready access to alternative supplies (Tables 13-3a and 13-3b).

This section discusses potential costs to municipal and industrial service providers, identified in Chapter 13, concerning different activities they may undertake to secure reliable water supplies.

Potential effects on ratepayers in affected irrigation districts within the plan area also are evaluated. In addition to potential effects within the plan area, implementation of the LSJR alternatives under drought conditions could result in water supply reductions within the SFPUC retail service area, and within the service areas of the 27 agencies in Alameda, San Mateo, and Santa Clara Counties that purchase wholesale water from SFPUC. The analysis presented in this section (and described in greater detail in Appendix L, *City and County of San Francisco Analyses*) assumes that under LSJR Alternatives 2, 3, and 4, during drought periods, SFPUC could meet its potential water supply shortage by buying water from MID and TID. However, due to the uncertainties of this type of water transfer (i.e., price of water, quantity of water available, willingness of parties to enter into an agreement), other actions that SFPUC might undertake to ensure a reliable supply of water for its service area also are considered (primarily in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, and summarized in Appendix L).

This section first describes M&I water supply conditions in the plan area and addresses potential effects that the LSJR alternatives may have on these water districts and their ratepayers. The section then describes M&I water supply conditions in the SFPUC service area and assesses potential indirect effects of the LSJR alternatives on water supply costs and the regional economy within that service area. Additional details of the assessment for potential M&I water supply effects in the SFPUC service area are included in Appendix L.

M&I Water Supply Conditions in the Plan Area and Potential Water District and Ratepayer Effects

This section addresses potential economic effects of reduced surface water diversions on affected water districts and ratepayers within the plan area under LSJR Alternatives 2, 3, and 4. The following assessment uses three of the service providers in the plan area as examples: SSJID, SEWD, and MID. The discussion first presents information on water usage, types of uses served, rate structures, and facility improvement plans for each district, followed by a qualitative assessment of the potential economic effects on these and other districts (and ratepayers) in the plan area using information presented in Chapter 13, *Service Providers*, and Chapter 16, *Evaluation of Other Indirect and Additional Actions*. These districts exhibit certain characteristics that are important to assessing potential economic effects, as they rely on surface water to meet some or all of their demand and they have agreements to either provide surface water to other water users or receive surface water.

Affected Water Districts

Water service providers in the plan area obtain their water supplies by either diverting surface water from one or more of the three eastside tributaries (see Table 13-2) or by pumping groundwater from aquifers (see Tables 13-3a and 13-3b). Some irrigation districts also have contracts or agreements to obtain water supplies from other water users, including water districts or conservation districts. Irrigation districts within the plan area obtain most of their water supply from surface water diversions; other water users primarily rely on groundwater, or a combination of groundwater and surface water, for their water (see Tables 13-3a and 13-3b). As identified in Chapter 13, *Service Providers* (see Table 13-2), five irrigation districts receive surface water from the Stanislaus, Tuolumne, and Merced Rivers, and 13 other water users, including water districts and conservation districts, obtain some of its water from one of the primary surface water diverters.

South San Joaquin Irrigation District

SSJID, together with OID, holds contract rights with the U.S. Bureau of Reclamation (USBR) to divert 600 thousand acre-feet (TAF) of water from the Stanislaus River. Water usage by type of use within the SSJID is identified in Table 20.3.3-1.

Table 20.3.3-1. South San Joaquin Irrigation District Water Usage by Type of Use

Type of Use	Usage (acre-feet)
Treated Water for Cities of Lathrop, Manteca, and Tracy	19,263 (2014)
Groundwater Recharge from Distribution Seepage and Applied Irrigation Water	132,513 (2014)
SSJID Water Transfers	325 (40,150 to San Luis & Delta-Mendota Water Authority in 2013)
Supplemental Water to Improve Flow for Chinook Salmon	(Average of 3,529 from 2000–2010)

Source: SSJID 2015a.

SSJID charges a flat rate of $24 per acre for water service to each parcel performing irrigation, with a $50 minimum charge. In addition, SSJID charges a groundwater recharge fee of $12 per acre for parcels of more than 10 acres with a $25 minimum charge, as long as the parcel is subject to an Irrigation Service Abandonment Agreement (ISAA). In 2013, the district enacted a $3 per AF volumetric charge for water. However, starting in 2016, the district plans to have a two-tier volumetric charge, where it increases to $10 per AF if water use exceeds 48 inches per year (Table 20.3.3-2). Finally, since 2010, the district also has imposed a pressurized water charge of $30/AF for the first 3 AF/y and $40/AF in excess of 3 AF/y for customers served with pressurized water by the District's Irrigation System Improvement Project

Table 20.3.3-2. South San Joaquin Irrigation District2016 Water Rate Structure

Category of Charge	Cost in $/Acre (AC) or $/Acre-Foot (AF)
Fixed Charge	None
Flat Rate	$24/AC (with a $50 minimum)
Groundwater Recharge Fee (for parcels of 10+ acres, subject to an ISAA)	$12/AC (with a $25 minimum)
Volumetric—Tier 1 (water use ≤ 48"/y)	$3/AF
Volumetric—Tier 2 (water use > 58"/y)	$10/AF
Pressurized Water Charge (first 3 AF/y)	$30/AF
Pressurized Water Charge (above 3 AF/y)	$40/AF

Source: SSJID 2015b.

Although the district does not have a fixed capital cost fee, it is allowed by district law to levy assessments for maintenance projects. The district may also collect charges for any services furnished. The second tier volumetric charges (Table 20.3.3-2) were recently enacted to pay for the increased costs of ongoing maintenance and other pipeline costs.

The SSJID's 2011 capital improvement plan includes the following highlights.

- Expanding the Nick C. DeGroot Water Treatment Plant to increase the total output of the plant to 43,000 AF/y of water, which would provide sufficient capacity to supply Escalon with treated water.
- Constructing a new pipeline to Escalon.
- Constructing a 10-mile-long pressurized water delivery system to areas west of Ripon.
- Using newly installed electronic controllers on district groundwater pumps to measure groundwater salinity.
- Implementing a 2011 plan to provide drinking water to Ripon, which requires constructing a new pipeline.
- Supplying a new 80-acre annexation area with irrigation water from existing irrigation facilities.

Stockton East Water District

SEWD provides water to the CalWater Services Company, the Stockton Municipal Utility District, and very small amounts of water to the County of San Joaquin. District surface water is diverted from the Stanislaus River and the Calaveras River. Surface water is stored in two reservoirs and treated at the Dr. Joe Waidhofer water treatment plant. The district provides about 12,400 AF/y of water for urban uses, and about 117,400 AF/y for agricultural uses (SEWD 2014).

As of January 2015, SEWD's rate structure for water included both fixed charges and volumetric charges (Table 20.3.3-3). Also included is a base monthly charge that allocates costs of the Treatment Plant Budget (SEWD 2014). Groundwater production costs are estimated during each update of the water management plan.

Table 20.3.3-3. Stockton East Water District Rate Structure and Units Billed, by Type of Use

Charges	Charge Units	Units Billed During Year	Collected
Fixed Charges			
Urban			
Domestic Groundwater	$37.50/Well	5,042 Wells	$218, 549
Agricultural			
Surface water	$20/AF	4,150 AF	$83,008
Agricultural Groundwater	$4.58/AF	117,434 AF	$537,806
Volumetric Charges			
Urban			
Municipal Groundwater	$164.31/AF	16,122 AF	$2,506,012
Agricultural			
Metered Surface Water	$20/AF	18,965 AF	$379,304

Source: SEWD 2014.

AF = acre-feet

According to the 2014 SEWD Water Management Plan, no new treatment facilities or reservoirs are planned; however, the district has expressed interest in securing additional supplemental supplies from the Calaveras River (SEWD 2014).

Modesto Irrigation District

Water usage by type of use within the MID service area is shown in Table 20.3.3-4. As shown, irrigation water accounts for the largest share (65 percent) of the total water usage in the district.

Table 20.3.3-4. Modesto Irrigation District Water Usage in 2012, by Type of Use

Type of Use	Usage (2012) (acre-feet)
Surface Water—Irrigation	278,800
M&I Treated Surface Water	32,661
Groundwater Pumping—Irrigation (agency wells)	17,300
Groundwater Pumping—M&I (agency wells)	28,700
Groundwater Pumping—Irrigation (private wells)	81,200

Source: MID 2015a.

As of March 2015, MID's water rate structure included both a fixed charge and a four-tier volumetric charge (Table 20.3.3-5). If a customer takes no surface water, the landowner is charged a facilities maintenance fee that is half of the fixed charge, or $20 per acre. Provisions of the Amended and Restated Treatment and Delivery Agreement (ARTDA) reached between MID and the City of Modesto in 2005 allow MID the option to pass higher costs on to water customers, including the City of Modesto, if the state of California levies fees or other charges on MID.

Table 20.3.3-5. Modesto Irrigation District Water Rate Structure

Category	Cost $/Acre (AC) or $/Acre Foot (AF)
Fixed Charge	$40.00/AC
Volumetric—Tier 1 (water use ≤ 24"/y)	$1.00/AF
Volumetric —Tier 2 (24"/y < water use ≤ 36"/y)	$2.00/AF
Volumetric—Tier 3 (36"/y < water use ≤ 42"/y)	$3.00/AF
Volumetric—Tier 4 (42"/y < water use)	$10.00/AF

Source: MID 2015b.

MID is presently moving forward on Phase Two of its Modesto Regional Wastewater Treatment Plant (MRWTP) project, which would expand water treatment capacity to 67,000 AF. As part of the project, new storage tanks and pipelines are expected to be built. During Phase One, MID and the City of Modesto developed a long-term water management plan, which included combining well water with surface water supplies from the Tuolumne River. In addition to water supply, MID also operates an extensive power grid, and the capital costs associated with the power grid are allocated jointly with the water infrastructure costs as part of the Capital Infrastructure Budget (MID 2013).

Potential Effects of the LSJR Alternatives

The LSJR alternatives are expected to result in reduced surface water diversions on the Stanislaus, Tuolumne, and Merced Rivers. The reduced surface water diversion could increase the cost of operations for irrigation and water districts in the plan area. This effect, in turn, could also indirectly affect the customers of the affected water service providers. This section presents an evaluation of these potential effects, including a qualitative assessment on how affected service providers can recover the investment costs of securing other reliable water supplies.

Potential Changes in Water Supply Costs

As discussed in Chapter 13, *Service Providers*, the extent of reduced surface water diversions on the amount of water in the eastside tributaries would vary by alternative. The average percent reduction in water supply on the Stanislaus, Tuolumne, and Merced Rivers is between 2 and 6 percent for LSJR Alternative 2, between 12 and 16 percent for LSJR Alternative 3, and between 32 and 35 percent for LSJR Alternative 4. The extent to which these reductions in surface water diversions would affect water supplies delivered by irrigation and water districts in the plan area would, however, be largely determined based on a number of factors that underlie how each affected service provider obtains its respective water supplies. These factors include a district's established water rights or contracts, the types of uses that water service providers supply, existing (district and others) policies affecting the distribution of water supplies, and local and state regulations. As described in Chapter 13 some water supply contracts include provisions that dictate when and how much surface water can be received by other water users from irrigation districts.

Other important considerations in assessing the extent of potential effects of reduced surface water supplies include a district's ability to expand water production, as needed, from current water sources (e.g., groundwater), its ability to potentially develop alternative water supplies, and the effectiveness of implementing demand-side management measures. As an example, service providers that currently rely on groundwater as their primary source of water (e.g., Central San Joaquin Water Conservation District, Manteca, Ripon, and Escalon) could potentially expand use of groundwater, assuming that additional pumping of groundwater is economically feasible. This situation would be expected to minimize potential cost effects of LSJR Alternatives 2, 3, and 4. Service providers that rely substantially on surface water diversions from the eastside tributaries (e.g., Cities of Modesto and Tracy), however, could experience more substantial cost effects, depending on the factors identified above.

As indicated in Chapter 13, some service providers that cannot expand production from current water sources may need to construct new water supply infrastructure or modify existing infrastructure to obtain water supplies from other sources. Alternatively, water conservation efforts may be effective in offsetting some of the cost effects associated with developing new supplies. According to information recently published by the State Water Board (2016), statewide cumulative water conservation savings in response to Executive Order (EO) B-29-15, State of Emergency Due to Severe Drought Conditions, totaled 23.9 percent between June 2015 and February 2016, compared with the same months in 2013. Ultimately, affected water districts would need to consider the capital and operating costs of acquiring alternative water supplies, including conservation actions, and how these costs could affect the structure of water rates. Estimated costs of developing some presumably feasible alternative water supplies, which are discussed in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, are summarized in Table 20.3.3-6.

Table 20.3.3-6. Cost Estimates for Developing Alternative Water Supplies

Source	Cost Estimate
Water Transfers	$1,716 per AF for an Environmental Water Account contract sale or $310 per AF for a long-term transfer[a]
Substitution of Surface Water with Groundwater	$57–$76 per AF for groundwater pumping electrical costs; $102–$153 per AF annually for total operations and maintenance cost of a groundwater project; $1,938 per AF based on entire operating budget and total groundwater production
Aquifer Storage and Recovery	$158–$238 per AF annually (20-year amortized cost)
Recycled Water Sources:	$400–$2,100/AF for landscape and agricultural irrigation (including capital, operations, and maintenance); $700–$1,200/AF for direct potable reuse (including capital, operations, and maintenance)

Source: Chapter 16, *Evaluation of Other Indirect and Additional Actions*, Section 16.2.

AF = acre-foot

[a] The section below titled *M&I Water Supply Conditions in the SFPUC Service Area and Potential Cost, Ratepayer, and Regional Economic Effects* of the LSJR alternatives discusses the costs associated with a water transfer specific to SFPUC.

Potential Ratepayer Effects

Ratepayers in districts that substantially rely on surface water diversions from the eastside tributaries, and where current rates do not account for unexpected capital costs, would likely be the service providers most affected by the additional costs of replacing lost surface water supplies. Over the long term, most districts would be expected to recover most, if not all, capital costs through rate adjustments. Certain water service provider may consider temporarily halting construction for new treatment facilities, as a project could become less economically viable as a result of reduced surface water diversions; however, over time, districts would be expected to re-spread the fixed costs of its projects, whether completed or not, among their ratepayers to achieve the revenue needed to remain economically viable. The potential impacts of reduced surface water supplies could be largely offset if cost-effective alternative supplies are available, similar to those described in Table 20.3.3-6.

A recent economic analysis of implementing EO B-29-15 (M-Cubed et al. 2015) provides additional insight on the potential economic effects from LSJR Alternatives 2, 3, and 4. Although there are fundamental differences in the actions being taken under the plan amendments and EO B-29-15 (implementation of the EO would result in a substantial reduction in the demand for water by essentially restricting water use, whereas the LSJR alternatives would result in reduced surface water supplies), both actions would not only affect water service providers, but also their ratepayers. Over the long term, any additional net costs to affected water service providers would likely be passed on to the ratepayers, unless specific provisions restrict this action. As presented in the M-Cubed economic impact analysis of EO B-29-15, impacts of restricted water use would principally consist of reduced net revenue for urban water districts and lost benefits for businesses and ratepayers who could have used the water productively. Both types of costs ultimately would be borne by water users, since water utilities would have to adjust their service charges and rates over time to recover the forgone net revenue from ratepayers. Similar actions and ratepayer consequences would be expected from implementing LSJR Alternatives 2, 3, and 4. However, these impacts are expected to vary significantly by district as a result of water use differences, established institutional/legal measures, water rates, and opportunities for obtaining water supplies from other sources.

As highlighted by the differences in sources of water, types of uses and water rates for the three example water providers characterized above, each service provider in the plan area has its own unique set of circumstances (e.g., institutional constraints affected by user types, rate structures, need for new facilities) within which it can react to reduced surface water supplies. As established by state law, the intent of regularly updating water management plans is to provide districts with an opportunity to consider how changes in supply and demand conditions potentially affect each district and its ratepayers. Although water service providers (both primary diverters and other water users) that rely less on surface water would appear to be less vulnerable than other service providers, this is not necessarily the case given the many factors that must be considered. However, service providers with cost effective opportunities to tap alternative sources of water, such as groundwater or water transfers, would be best positioned to minimize potential costs effects of a reduced surface water supply.

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood to change economic effects as it would allow the unimpaired flow requirement to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow). For LSJR Alternative 2 an increase from 20 percent to 30 percent of the unimpaired flow would likely result in different effects as compared to those shown above for LSJR Alternative 2, depending upon flow conditions and frequency of the adjustment. As such, under LSJR Alternatives 2 or 3, if the percentage of unimpaired flow is increased with adaptive implementation method 1, water supply costs to affected water districts also would likely increase as these districts would need to develop more costly sources of water supply than those developed without adaptive implementation. On the other hand, under LSJR Alternatives 3 and 4, if the percent of unimpaired flow is reduced with adaptive implementation method 1, water supply costs to affected water districts would be expected to be somewhat less than without adaptive implementation.

M&I Water Supply Conditions in the SFPUC Service Area and Potential Cost, Ratepayer, and Regional Economic Effects

Introduction

SFPUC is a department of CCSF that provides retail drinking water and wastewater services to San Francisco, wholesale water to three Bay Area counties, and green hydroelectric and solar power to San Francisco's municipal departments. The amount of water SFPUC delivers to its service area is largely dependent on water delivered from the Tuolumne River Watershed. LSJR Alternatives 2, 3, and 4 may affect the amount of surface water diversions to the SFPUC service area.

This discussion presents background information on SFPUC's service area and ratepayers. It is followed by an analysis of how the LSJR alternatives could potentially affect water supply costs, the regional economy, and ratepayers in the service area. In addition, the potential economic effects of purchasing water (i.e., water transfers) by SFPUC from willing sellers in the Central Valley are analyzed. Cost information for other actions that SFPUC could take instead of purchasing water can be found in Chapter 16, *Evaluation of Other Indirect and Additional Actions* and summarized in Appendix L, *City and County of San Francisco Analyses*. Where appropriate, sections, tables, and figures from Chapter 16 and Appendix L are cited in this discussion.

Service Area Conditions

CCSF, through the SFPUC, owns and operates a regional water system that provides retail water directly to customers in San Francisco and wholesale water to 27 water agencies and water companies in three Bay Area counties, including those serving parts of Alameda, San Mateo, and Santa Clara Counties. CCSF also delivers water to a small number of isolated retail and wholesale customers along the water system, including customers in Tuolumne County. In 2010, the SFPUC retail and wholesale service areas included service to about 2.6 million residents.

The SFPUC water system has the capacity to deliver about 265 mgd (296,800 AF/y) on average, of which about 85 percent is from the Tuolumne River Watershed through SFPUC's Hetch Hetchy Project, and about 15 percent is from the combined Alameda and Peninsula Watersheds. During drought periods, the water provided by the Hetch Hetchy Project can amount to more than 93 percent of the total water delivered within SFPUC's retail and wholesale service areas.

As Table 20.3.3-7 shows, individual water agencies rely on SFPUC supplies to varying extents. Based on fiscal year 2010–2011 water demands and deliveries, SFPUC provided at least 90 percent of the water used by 19 of the 27 wholesale agencies it served that year. An additional five agencies received at least half their water supply from SFPUC. Water use by customer class also varies widely among the wholesale agencies, as shown in Table 20.3.3-8. Across the entire wholesale service area, about 59 percent was delivered to residential customers, 21 percent to commercial and industrial customers, 11 percent to government and other users, and 9 percent to dedicated irrigation users.

Table 20.3.3-7. SFPUC Water Deliveries to Retail and Wholesale Agencies and Reliance of Agencies on San Francisco Public Utilities Commission Water, 2010

County/Agency	SFPUC Water Deliveries (mgd)	Percent of Total SFPUC Water Deliveries	Percent of Total Demand Met by SFPUC Regional Water System[a]
Retail Agency			
San Francisco City/County San Francisco Retail Area	76.50[b]	33.9	100.0
Wholesale Agencies			
Alameda County			
Alameda County Water District	10.81	4.8	18.3
City of Hayward	17.25	7.6	100.0
County subtotal	28.06	12.4	41.5
San Mateo County			
City of Brisbane/Guadalupe Valley Municipal Improvement District[c]	0.58	0.3	100.0
City of Burlingame	3.93	1.7	93.1
California Water Service Company[d]	32.57	14.4	95.1
Coastside County Water District	1.82	0.8	90.2
Cordilleras Mutual Water Association	0.01	0.0	100.0
City of Daly City	3.21	1.4	69.2
City of East Palo Alto	1.81	0.8	100.0
Estero Municipal Improvement District	4.90	2.2	100.0
Town of Hillsborough	2.97	1.3	100.0
City of Menlo Park	3.04	1.3	100.0
Mid-Peninsula Water District	2.87	1.3	100.0
City of Millbrae	2.24	1.0	99.1
North Coast County Water District	3.02	1.3	100.0
City of Redwood City	9.61	4.3	94.3
City of San Bruno	1.46	0.6	42.7
Westborough Water District	0.84	0.4	100.0
County subtotal	74.88	33.1	92.4
Santa Clara County			
City of Milpitas	6.28	2.8	61.0
City of Mountain View	8.95	4.0	82.8
City of Palo Alto	10.99	4.9	93.6
Purissima Hills Water District	1.75	0.8	100.0
City of San Jose (north)	4.13	1.8	90.8
City of Santa Clara	2.35	1.0	10.3

County/Agency	SFPUC Water Deliveries (mgd)	Percent of Total SFPUC Water Deliveries	Percent of Total Demand Met by SFPUC Regional Water System[a]
Stanford University	2.14	0.9	66.5
City of Sunnyvale	9.92	4.4	44.3
County subtotal	46.51	20.6	54.4
TOTAL RETAIL & WHOLESALE	**225.95**	**100.0**	**73.6**

Sources: SFPUC 2011a; Bay Area Water Supply and Conservation Agency 2012; Appendix L, *City and County of San Francisco Analyses,* Table L.3-1.

mgd = million gallons per day (1 mgd equals 1,120.147 acre-feet of water).

[a] Based on water production and purchases during fiscal year 2010–2011.

[b] Includes water delivered to Lawrence Livermore Lab and the Groveland Community Services Districts. Excludes groundwater used for City of San Francisco irrigation uses and groundwater delivered to Castlewood and Sunol golf courses.

[c] The City of Brisbane and the Guadalupe Valley Municipal Improvement District represent two separate wholesale customers to SFPUC. However, their water demand data is reported together.

[d] CWS provides water to three separate service areas (Bear Gulch, Mid Peninsula, and South San Francisco).

Table 20.3.3-8. Percentage Distribution of San Francisco Public Utilities Commission Water Deliveries by Customer Class, 2010

County/Agency	Residential	Commercial & Industrial	Government & Other[a]	Dedicated Irrigation[b]
Retail Agency				
San Francisco City/County	55.2	32.1	12.7	NA
San Francisco Retail Area[c]				
Wholesale Agencies[d]				
Alameda County				
Alameda County Water District	61.0	14.9	14.5	9.6
City of Hayward	51.6	19.1	18.1	11.2
County subtotal	58.3	16.1	15.5	10.1
San Mateo County				
City of Brisbane/Guadalupe Valley Municipal Improvement District[c]	38.3	27.6	5.4	28.7
City of Burlingame	55.0	23.2	16.7	5.1
California Water Service Company[d]	67.5	22.2	10.3	0.0
Coastside County Water District	60.8	24.1	6.2	8.9
Cordilleras Mutual Water Association	100.0	0.0	0.0	0.0
City of Daly City	79.6	12.1	6.3	2.0
City of East Palo Alto	76.7	17.8	5.5	0.0
Estero Municipal Improvement District	61.4	11.0	4.1	23.5

County/Agency	Residential	Commercial & Industrial	Government & Other[a]	Dedicated Irrigation[b]
Town of Hillsborough	94.7	0.2	3.7	1.4
City of Menlo Park	44.3	33.8	11.3	10.6
Mid-Peninsula Water District	60.7	14.8	24.5	0.0
City of Millbrae	66.4	16.1	10.1	7.4
North Coast County Water District	82.8	7.4	7.6	2.2
City of Redwood City	64.8	17.2	5.7	12.3
City of San Bruno	68.2	18.2	13.6	0.0
Westborough Water District	68.8	16.7	3.7	10.8
County subtotal	67.5	18.6	9.4	4.5
Santa Clara County				
City of Milpitas	43.0	24.5	13.6	18.9
City of Mountain View	53.2	18.8	4.2	23.8
City of Palo Alto	53.9	19.8	19.1	7.2
Purissima Hills Water District	93.6	0.0	5.8	0.6
City of San Jose (north)	22.9	43.2	4.5	29.4
City of Santa Clara	43.4	40.6	9.7	6.3
Stanford University	29.1	18.3	19.0	33.6
City of Sunnyvale	61.6	19.9	7.6	10.9
County subtotal	49.6	26.5	10.4	13.5
TOTAL WHOLESALE	**58.5**	**20.8**	**11.4**	**9.3**

Sources: SFPUC 2011a; Bay Area Water Supply and Conservation Agency 2012; Appendix L, *City and County of San Francisco Analyses*, Table L.3-2.

NA = not available.

[a] Includes government uses, recycled water uses, unaccounted-for uses, meter under-registration loses, and other system losses.

[b] Includes dedicated irrigation uses for both private and government customers.

[c] Based on 2010 demands. Does not included city irrigation uses and golf course uses served by groundwater.

[d] Based on fiscal year 2010–2011 demands.

Baseline Ratepayer Conditions

SFPUC funds its water system through two separate budgets, its Hetch Hetchy Water and Power Budget and its Water Enterprise Budget. The Hetch Hetchy Water and Power Budget operates the collection and conveyance of approximately 85 percent of SFPUC's total water supply, employing a system of reservoirs, hydroelectric power plants, aqueducts, pipelines, and transmission lines that carry water and power from Hetch Hetchy to customers in San Francisco and to SFPUC's wholesale customers elsewhere in the Bay Area. The Water Enterprise is responsible for collecting, treating, and distributing SFPUC's water supply to its retail and wholesale customers, as well as operating and maintaining pipelines in San Francisco and throughout the region, 27 pump stations, 28 dams and reservoirs, 9 water tanks, and 3 water treatment plants. An overview of recent budget expenditures under the Water Enterprise Budget and the water portion of the Hetch Hetchy Water and Power Budget are shown in Table L.3-3 in Appendix L, *City and County of San Francisco Analyses*.

SFPUC sets its retail water rates based on an independent rate study conducted at least once every 5 years. Retail water rates consist of a monthly service charge based on meter size and a commodity charge based on usage volumes. Annual rate increases for retail customers are set to meet project costs and debt coverage requirements. SFPUC's water rates for its 27 wholesale customers are based on the Water Supply Agreement established in 2009. In general, costs are apportioned to wholesale customers based on proportionate water use, and rates are reset annually to cover costs as mandated by the Water Supply Agreement. See Table L.3-4 for actual retail and wholesale water rates between 2008 and 2014.

Effects on M&I Water Supply in the SFPUC Service Area

This section addresses how the LSJR alternatives could potentially affect water supply costs, the regional economy, and ratepayers in the SFPUC service area. Regional economic effects are presented within each county in the four-county Bay Area region in which the SFPUC serves retail and wholesale customers. Additional details of the methods and assumptions can be found in Appendix L, *City and County of San Francisco Analyses*.

Potential Change in Water Supply Costs

As discussed in Section L.6 of Appendix L, *City and County of San Francisco Analyses,* LSJR Alternatives 2, 3, and 4 may affect the ability of SFPUC to supply water to its retail and wholesale customers under drought conditions. The magnitude of the effect under drought conditions depends on how the parties involved interpret the Fourth Agreement between CCSF and MID and TID, which currently governs the New Don Pedro Reservoir water bank account on the Tuolumne River. There are two possible scenarios,[6] which are described in Table 20.3.3-9a and referred to throughout the remainder of this evaluation. To assess the effects of additional water supply costs on the four-county Bay Area regional economy, it is assumed that the SFPUC would meet its water demands during severe drought periods (such as within the 6-year drought 1987–1992) by purchasing water from MID and TID. Under this assumption, water costs for SFPUC are estimated based on the predicted annual average water shortage during severe drought years under each of the LSJR alternatives, relative to baseline conditions. The annual average cost for SFPUC to replace lost surface water supplies was then calculated based on the following assumptions.

- During severe drought periods, SFPUC would replace reductions in water supplies by purchasing water at $1,000 per AF.
- No other costs to SFPUC would be required to wheel, treat, or distribute the purchased water beyond existing costs for Hetch Hetchy water. (Note that if the transferred water comes from Cherry or Eleanor Reservoirs instead of passing through Hetch Hetchy Reservoir, the water would need to be filtered, potentially resulting in additional cost.)
- SFPUC operations and maintenance costs to provide water from the Hetch Hetchy water system do not vary based on the amount of water annually delivered by the system. As a result, SFPUC

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[6] It cannot be predicted whether and how CCSF and the irrigation districts would agree to apportion responsiblity for meeting future flow requirements. In the past, the parties have agreed to either an allocation of storage credits or payments. Nonetheless, Appendix L, *City and County of San Francisco Analyses*, analyzes the potential water supply effects associated with the allocation of responsibility under paragraph (b) of Article 8 of the Fourth Agreement. Under Scenario 1, storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account. Under Scenario 2, storage credits would be reallocated even if CCSF has a negative balance in the water bank account. See Appendix L for more information.

water-production costs do not appreciably decline when less water is delivered during drought conditions. (System facilities still need to be operated and maintained regardless of the amount of water delivered through the system.) As a result, 100 percent of the $1,000 per AF purchase price for water transfers would be added to overall SFPUC costs to provide water from the Hetch Hetchy system.

Based on these assumptions, average annual water-shortage replacement costs for SFPUC are estimated in Table 20.3.3-9a. For the LSJR alternatives, SFPUC's annual severe-drought-period (1987–1992) water transfer costs are estimated to range from about $14 million to $30 million under Scenario 1 and from about $35 million to $208 million under Scenario 2.

Table 20.3.3-9a. Estimated San Francisco Public Utilities Commission Replacement Water Purchase Costs in Severe Drought Years (1987–1992) under the LSJR Alternatives

	Scenario 1[a]		Scenario 2[b]	
Alternative	Required Water Transfer (TAF)	Estimated Purchase Cost	Required Water Transfer (TAF)	Estimated Purchase Cost
LSJR Alternative 2	14	$14,000,000	35	$35,000,000
LSJR Alternative 3	27	$27,000,000	119	$119,000,000
LSJR Alternative 4	30	$30,000,000	208	$208,000,000

Source: Appendix L, *City and County of San Francisco Analyses,* Table L.6-1a.

TAF = thousand acre-feet.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

[b] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

Assuming a "worst-case" return period of one severe 6-year drought every 21 years, the mean annual costs to purchase water in drought years shown in Table 20.3.3-9a would be spread over 21 years, instead of over only 6 drought years. The mean annual reduction in water supply compared to baseline would range from 4–9 TAF per year under scenario 1 to 10–71 TAF per year under scenario 2 (Table 20.3.3-9b). The distributed costs would be similarly reduced—long-term annual average costs for the LSJR alternatives are estimated to range from about $4–$9 million under Scenario 1 and from about $10–$71 million under scenario 2.

It should be noted, however, that these estimated costs to be incurred by SFPUC and its wholesale agencies due to a water supply reduction during a severe drought would not be expected to occur evenly over a defined period, either 6 years or 21 years, as suggested by the calculation of an average annual value, based either on the example 1987–1992 drought or on the available 21-year period of record used for assessing water bank deficits. Consequently, while the calculation of an average annual cost is useful for evaluating potential effects (both cost and regional economic effects) relative to ongoing budgetary conditions, the temporal accuracy of calculating an average annual cost is somewhat uncertain. Appendix L, *City and County of San Francisco Analyses*, briefly provides additional consideration of the return interval of such a severe drought.

Table 20.3.3-9b. Estimated Mean Annual (1983–2003) San Francisco Public Utilities Commission Replacement Water Purchase Costs in Severe Drought Years under the LSJR Alternatives

	Scenario 1[a]		Scenario 2[b]	
Alternative	Required Water Transfer (TAF)	Estimated Purchase Cost	Required Water Transfer (TAF)	Estimated Purchase Cost
LSJR Alternative 2	4	$4,000,000	10	$10,000,000
LSJR Alternative 3	8	$8,000,000	34	$34,000,000
LSJR Alternative 4	9	$9,000,000	71	$71,000,000

Source: Appendix L, *City and County of San Francisco Analyses,* Table L.6-1b.

TAF = thousand acre-feet.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

[b] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

For assessing regional economic effects of the water supply impacts, the costs in Tables 20.3.3-9a and 20.3.3-9b are distributed to SFPUC water users by agency and user category. The assumptions underlying this distribution are described in Appendix L. After distributing the water replacement cost among SFPUC's different customers, it is totaled by county under each of the LSJR alternatives for scenarios 1 and 2.

It is assumed that SFPUC would purchase and transfer additional water supplies from the Tuolumne River Watershed to offset water shortages during drought periods. This would result in substantially lower estimates of regional impacts than if it is assumed that SFPUC would cut back its water deliveries (i.e., impose shortages) to its retail and wholesale customers, particularly in assessing impacts for commercial and industrial water users. See Sunding 2014 for an assessment of how assumed water shortages, as opposed to the water replacement approach used in this analysis, within the Hetch Hetchy Regional Water System Service Area could impact SFPUC.

Assessment Methods for Potential Effects on the Regional Economy

SFPUC could purchase water to offset water shortages during drought periods (described above) and, in turn, could pass the additional cost on to its retail customers in the form of a temporary rate surcharge and to its wholesale customers in the form of higher wholesale water rates. Wholesale customers could then pass the higher costs to their own retail customers through a temporary rate surcharge. As higher water costs filter through the four-county Bay Area region, less discretionary income would be available for water customers to spend on goods and services, resulting in a reduction of economic output (sales) and employment throughout the region.

The IMPLAN input-output economic model was used to analyze the effects on the regional economy. IMPLAN is widely used for assessing regional economic effects of regulatory and policy actions, despite some limitations in evaluating cost-related impacts. The model was used to estimate the indirect and induced economic activity associated with direct changes in water costs for customers within SFPUC's retail and wholesale service areas. Using 2010 IMPLAN county-level data files, individual IMPLAN models were constructed for Alameda, San Francisco, San Mateo, and Santa Clara Counties.

The regional economic effects of rate surcharges would largely be determined by the reactions of end-use customers to temporarily higher water rates, which includes actions taken by residential customers, commercial and industrial customers, government water users, and dedicated irrigation water users. Predicting how the various classes of water customers would react to temporarily higher water rates is complex. Faced with higher water costs during drought years, residential customers could decrease their water use or they could decrease their spending on other goods and services to compensate for higher water utility bills. If rate increases are relatively small, however, households may not change their spending habits at all by reducing savings and/or investments, by charging purchases using credit cards, or by borrowing money. Commercial and industrial water customers could account for the additional cost of water by reducing profits, purchasing less water and/or decreasing production levels, raising product/service prices, or changing their mix of production inputs to reduce non-water-related costs. For institutional water users responding to temporarily higher water costs, government agencies could lay off staff or reduce spending on other operational inputs. However, the need for agencies to maintain staffing and service levels set through agency budgeting suggests that temporary economic effects of higher water costs would be limited. For the SFPUC retail service area, dedicated city irrigation demands are met using groundwater supplies, which have been excluded from this assessment.

Several assumptions are made to simplify the modeling approach for assessing the regional economic effects of the LSJR alternatives. These assumptions are presented in Appendix L, *City and County of San Francisco Analyses*.

Results for Potential Effects on the Regional Economy

Under Scenario 1 (storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account), decreased spending on goods and services resulting from increased water costs for residential, commercial, industrial, and institutional water users could cause industrial output to decline throughout the Bay Area region during drought periods. The reduction in economic output is estimated to range from $16.2 million under LSJR Alternative 2 to $35.3 million under LSJR Alternative 4 (Table 20.3.3-10). While large, these reductions during severe drought periods (e.g., 1987–1992) would be relatively small in the context of the regional economy, ranging from 0.03 to 0.05 percent of total output.

Table 20.3.3-10. Estimated Average Annual Water Supply Effects (Direct, Indirect, and Induced) during Severe Drought Years on Economic Output in the Bay Area Region Associated with LSJR Alternatives 2, 3, and 4: Scenario 1[a]

Economic Effects (2010 Dollars)	2010 Baseline	Change from Baseline by LSJR Alternative		
		LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Alameda County				
Total County Output ($ Millions)	143,450.6	-2.8	-5.5	-6.2
% of Output	100	-0.02	-0.04	-0.04
San Francisco County				
Total County Output ($ Millions)	124,678.1	-5.6	-10.9	-12.2
% of Output	100	-0.04	-0.09	-0.10
San Mateo County				
Total County Output ($ Millions)	99,088.3	-4.4	-8.5	-9.5
% of Output	100	-0.04	-0.09	-0.10
Santa Clara County				
Total County Output ($ Millions)	278,082.8	-3.4	-6.6	-7.4
% of Output	100	-0.01	-0.02	-0.03
Bay Area Region				
Total Region Output ($ Millions)	645,299.8	-16.2	-31.4	-35.3
% of Output	100	-0.03	-0.05	-0.05

Sources: 2010 IMPLAN county data files and IMPLAN model runs for LSJR alternatives; Appendix L, *City and County of San Francisco Analyses,* Table L.6-2.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

The total regional effects of the LSJR alternatives on employment under Scenario 1 are similar, in relative terms, to the effects on economic output. During drought periods, the average annual number of jobs within the region are predicted to decrease by 117 (0.01 percent) under LSJR Alternative 2, 226 (0.01 percent) under LSJR Alternative 3, 254 (0.01 percent) under LSJR Alternative 4 (Table 20.3.3-11). Job losses under LSJR Alternative 4 are predicted to be largest in San Francisco County (84 jobs) and San Mateo County (71 jobs).

Table 20.3.3-11. Estimated Average Annual Water Supply Effects (Direct, Indirect, and Induced) during Severe Drought Years on Jobs in the Bay Area Region Associated with LSJR Alternatives 2, 3, and 4: Scenario 1[a]

Economic Effects	2010 Baseline	Change from Baseline by LSJR Alternative		
		LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Alameda County				
Total County Jobs	872,636	-21	-41	-46
% of Jobs	100	<-0.01	<-0.01	-0.01
San Francisco County				
Total County Jobs	734,063	-39	-75	-84
% of Jobs	100	-0.01	-0.01	-0.01
San Mateo County				
Total County Jobs	464,194	-33	-64	-71
% of Jobs	100	-0.01	-0.01	-0.02
Santa Clara County				
Total County Jobs	1,112,308	-24	-47	-53
% of Jobs	100	<-0.01	<-0.01	<-0.01
Bay Area Region				
Total Region Jobs	3,183,201	-117	-226	-254
% of Jobs	100	<-0.01	<-0.01	<-0.01

Sources: 2010 IMPLAN county data file, and IMPLAN model runs for LSJR alternatives; Appendix L, *City and County of San Francisco Analyses,* Table L.6-3.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

Under Scenario 2 (storage credits would be reallocated even if CCSF has a negative balance in the water bank account) output and job losses during drought periods are predicted to be substantially higher than under Scenario 1 because replacement water needs and related costs to customers would be much larger. Annual output reductions in the Bay Area region are estimated to range from $40.5 million to $243.6 million under LSJR Alternatives 2, 3, and 4 (Table 20.3.3-12). In the context of the overall Bay Area region economy, these reductions would represent 0.06 and 0.38 percent of total output, respectively. Similarly, job losses would be relatively small, ranging from 292 to 1,756 jobs across LSJR Alternatives 2, 3, and 4, which represent 0.01 and 0.06 percent of all regional jobs, respectively (Table 20.3.3-13).

Table 20.3.3-12. Estimated Average Annual Water Supply Effects (Direct, Indirect, and Induced) during Severe Drought Years on Economic Output in the Bay Area Region Associated with the LSJR Alternatives 2, 3, and 4: Scenario 2[a]

		Change from Baseline by LSJR Alternative		
Economic Effects (2010 Dollars)	2010 Baseline	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Alameda County				
Total County Output ($ Millions)	143,450.6	-7.1	-24.5	-43.0
% of Output	100	-0.05	-0.17	-0.30
San Francisco County				
Total County Output ($ Millions)	124,678.1	-14.0	-48.2	-84.2
% of Output	100	-0.11	-0.39	-0.68
San Mateo County				
Total County Output ($ Millions)	99,088.3	-10.9	-37.6	-65.5
% of Output	100	-0.11	-0.38	-0.66
Santa Clara County				
Total County Output ($ Millions)	278,082.8	-8.5	-29.2	-51.0
% of Output	100	-0.03	-0.11	-0.18
Bay Area Region				
Total Region Output ($ Millions)	645,299.8	-40.5	-139.5	-243.6
% of Output	100	-0.06	-0.22	-0.38

Sources: 2010 IMPLAN county data files and IMPLAN model runs for LSJR alternatives; Appendix L, *City and County of San Francisco Analyses,* Table L.6-4.

[a] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

Table 20.3.3-13. Estimated Average Annual Water Supply Effects (Direct, Indirect, and Induced) during Severe Drought Years on Jobs in the Bay Area Region Associated with LSJR Alternatives 2, 3, and 4: Scenario 2[a]

		Change from Baseline by LSJR Alternative		
Economic Effects	2010 Baseline	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Alameda County				
Total County Jobs	872,636	-53	-181	-318
% of Jobs	100	-0.01	-0.02	-0.04
San Francisco County				
Total County Jobs	734,063	-97	-334	-583
% of Jobs	100	-0.01	-0.05	-0.08
San Mateo County				
Total County Jobs	464,194	-82	-282	-491
% of Jobs	100	-0.02	-0.06	-0.11
Santa Clara County				
Total County Jobs	1,112,308	-61	-209	-364
% of Jobs	100	-0.01	-0.02	-0.03
Bay Area Region				
Total Region Jobs	3,183,201	-292	-1,005	-1,756
% of Jobs	100	-0.01	-0.03	-0.06

Sources: 2010 IMPLAN county data files and IMPLAN model runs for LSJR alternatives; Appendix L, *City and County of San Francisco Analyses,* Table L.6-5.

[a] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

Assessment Methods for Potential Ratepayer Effects

Effects of SFPUC water purchases on water rates are evaluated based on the relative increase in overall SFPUC budget costs attributable to replacement water purchases under each alternative. Existing water rates that are annually established for both the retail and wholesale service areas reflect operating costs, debt service costs, capital costs, programmatic project costs, and reserve considerations. This ratepayer assessment uses the total SFPUC Water Enterprise and Hetch Hetchy Water budgets for fiscal year 2013–2014 as baselines for the assessment. The adopted fiscal year 2013–2014 budgets totaled $483.2 million, as shown in Appendix L, *City and County of San Francisco Analyses,* (Table L.3-3). These budgets account for the cost of producing, conveying, filtering, treating, and distributing water within the SFPUC service areas, as well as to defray the costs of past, current, and future projects. Existing water rates for SFPUC's retail and wholesale customers, which are largely driven by these budget costs, also are shown in Appendix L (Table L.3-4). For purposes of evaluating ratepayer effects, budgetary cost increases for SFPUC to replace water during drought conditions are assumed to result in proportional rate increases in SFPUC's retail and wholesale water rates, relative to the existing rates.

Results for Potential Ratepayer Effects

The budget effects of purchasing replacement water during severe drought periods (e.g. 1987–1992) under the LSJR alternatives are shown in Tables 20.3.3-14a and 20.3.3-14b and 20.3.3-15a and 20.3.3-15b. Compared to adopted fiscal year 2013–2014 SFPUC budget costs of $483.12million, water replacement costs in severe drought years under Scenario 1 would represent an increase in overall costs ranging from about 3 to 6 percent (Table 20.3.3-14a). These additional drought-period costs would presumably result in rate surcharges within the retail and wholesale service areas of about the same percentages, relative to existing water rates. For example, the drought-period rate surcharge in the SFPUC retail service area could cause existing rates for a single-family residential customer to rise by about 3 percent under LSJR Alternative 2, and by about 6 percent under LSJR Alternatives 3 and 4. Existing rates charged by SFPUC to its wholesale customers could increase by similar percentages.

Table 20.3.3-14a. Estimated SFPUC Budget Effects of Purchasing Replacement Water Supplies during Severe Drought Periods Associated with LSJR Alternatives 2, 3, and 4: Scenario 1[a]

	Baseline[b]	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Average Annual Water Replacement Costs ($ Millions)	--	14	27	30
Water Budget with Replacement Costs ($ Millions)	483.2	497.2	510.2	513.2
Percentage Change in Water Budget Expenditures	--	2.9%	5.6%	6.2%

Source: Appendix L, *City and County of San Francisco Analyses,* Table L.6-6.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

[b] Represents combined Adopted Water Enterprise and Hetch Hetchy Water budgets for fiscal year 2013–2014.

Using a longer-term period of record (1983 to 2003), the annual average water replacement costs (as derived in Table 20.3.3-9b) are much less than the costs within the severe drought period (1987 to 1992) described above. Under Scenario 1, estimated longer-term increases in budget expenditures range from 0.8 to 1.9 percent (Table 20.3.3-14b).

Table 20.3.3-14b. Estimated Longer-Term SFPUC Budget Effects of Purchasing Replacement Water Supplies during Severe Drought Periods Associated with LSJR Alternatives 2, 3, and 4: Scenario 1[a]

	Baseline[b]	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Average Annual Water Replacement Costs ($ Millions)	--	4	8	9
Water Budget with Replacement Costs ($ Millions)	483.2	487.2	491.2	492.2
Percentage Change in Water Budget Expenditures	--	0.8%	1.7%	1.9%

Source: Appendix L, *City and County of San Francisco Analyses,* Table L.6-8.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

[b] Represents combined Adopted Water Enterprise and Hetch Hetchy Water budgets for fiscal year 2013–2014.

For Scenario 2, the additional expenditures to purchase and transfer water during severe drought periods (e.g. 1987–1992) under the LSJR alternatives would be much higher than in Scenario 1, with cost increases ranging from about 7 to 43 percent of the baseline water budget (Table 20.3.3-15a). As a result, water rate increases during drought periods would be substantially higher than under Scenario 1. Drought-period rate surcharges in the SFPUC retail service area could raise existing rates for a single-family residential customers by about 7 percent under LSJR Alternative 2, by about 25 percent under LSJR Alternative 3, and by about 43 percent under LSJR Alternative 4. Existing rates charged by SFPUC to its wholesale customers could increase by similar percentages. Under Scenario 2, estimated longer-term increases in budget expenditures range from 2.1 to 14.7 percent (Table 20.3.3-15b).

Table 20.3.3-15a. Estimated SFPUC Budget Effects of Purchasing Replacement Water Supplies during Severe Drought Periods Associated with LSJR Alternatives 2, 3, and 4: Scenario 2[a]

	Baseline[b]	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Average Annual Water Replacement Costs ($ Millions)	--	35	119	208
Water Budget with Replacement Costs ($ Millions)	483.2	518.2	602.2	691.2
Percentage Change in Water Budget Expenditures	--	7.2%	24.6%	43.1%

Source: Appendix L, *City and County of San Francisco Analyses,* Table L.6-7.

[a] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

[b] Represents combined Adopted Water Enterprise and Hetch Hetchy Water budgets for fiscal year 2013–2014.

Table 20.3.3-15b. Estimated Longer-term SFPUC Budget Effects of Purchasing Replacement Water Supplies during Severe Drought Periods Associated with LSJR Alternatives 2, 3, and 4: Scenario 2[a]

	Baseline[b]	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Average Annual Water Replacement Costs ($ Millions)	--	10	34	71
Water Budget with Replacement Costs ($ Millions)	483.2	493.2	517.2	554.2
Percentage Change in Water Budget Expenditures	--	2.1%	7.0%	14.7%

Source: Appendix L, *City and County of San Francisco Analyses,* Table L.6-9.

[a] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

[b] Represents combined Adopted Water Enterprise and Hetch Hetchy Water budgets for fiscal year 2013–2014.

For the 27 individual water agencies that purchase wholesale water from SFPUC, the actual drought surcharges levied on their retail water customers (e.g., residential, commercial and industrial) would vary depending on the percentage of each district's overall water demand met by purchases from SFPUC. As identified in Appendix L, *City and County of San Francisco Analyses* (Table L.3-1), 19 of the water agencies served by SFPUC purchased at least 90 percent of their total water supply from SFPUC in 2010. Within the service areas of those agencies (e.g., the Cities of Hayward, East Palo Alto, Menlo Park), percentage increases in drought-period rates would likely be similar to increases in wholesale water rates under the LSJR alternatives. For water agencies that rely less on SFPUC water deliveries (e.g., the Cities of Santa Clara, Sunnyvale, and San Bruno), the rate surcharges attributable to the LSJR alternatives would presumably be lower. Additionally, rate increases for customer classifications within each agency would vary based on the rate-setting policies of each agency.

Sensitivity Analysis

In the results described above, the cost of water purchases from the irrigation districts (i.e., MID and TID) is assumed to be $1000 per AF. This assumed price is key to the analysis, and is derived based on a review of recent water purchases involving both MID and TID, as well as by other agricultural districts in California. Although this assumption is considered reasonable for the analysis, an argument also can be made for assuming either a higher or lower average cost per AF, given the many site- and time-specific factors that affect water transaction prices.

A limited review of relevant information concerning the cost of water in recent water purchases suggests that a reasonable cost range for agricultural-to-urban water transfers is $500 to $2000 per AF. Although many factors influence the relationship between the price of water and the extent of associated regional economic effects, assuming that this relationship is linear provides an order-of-magnitude approximation for the potential effects under different average water prices. In other words, the resulting economic effects assuming a water transfer price of $500 per AF could approximately halve the impacts discussed above, while a price of $2000 per AF could approximately double the impacts. Approximate impacts on total economic output and employment in the four-county Bay Area region (San Francisco, Alameda, San Mateo, and Santa Clara Counties) using water transfer prices of $500, $1000, and $2000 per AF are shown in Tables 20.3.3-16 and 20.3.3-17 under Scenarios 1 and 2 for the LSJR alternatives.

Table 20.3.3-16. Estimated Average Annual Water Supply Effects on Economic Output in the Four-County Bay Area Region during Severe Drought Years under LSJR Alternatives 2, 3, and 4 for Different Water Transfer Prices

Scenario	Water Transfer Price ($/AF)	Total Region Output ($ Millions)[c] 2010 Baseline	Change from Baseline under LSJR Alternative LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Scenario 1[a]	500	645,300	-8.1	-15.7	-17.7
	1000	645,300	-16.2	-31.4	-35.3
	2000	645,300	-32.4	-62.8	-70.6
Scenario 2[b]	500	645,300	-20.3	-69.8	-121.8
	1000	645,300	-40.5	-139.5	-243.6
	2000	645,300	-81	-279	-487.2

Source: 2010 IMPLAN county data files and IMPLAN model runs for LSJR alternatives; Appendix L, *City and County of San Francisco Analyses,* Table L.6-2 and L.6-4.

$/AF = dollars per acre-foot.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

[b] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

[c] Region consists of the four Bay Area counties: San Francisco, Alameda, San Mateo, and Santa Clara.

Table 20.3.3-17. Estimated Average Annual Water Supply Effects on Employment in the Four-County Bay Area Region during Severe Drought Years under LSJR Alternatives 2, 3, and 4 for Different Water Transfer Prices

		Total Region Employment (# of Jobs)[c]			
			Change from Baseline under LSJR Alternative		
Scenario	Water Transfer Price ($/AF)	2010 Baseline	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Scenario 1[a]	500	3,183,201	-58.5	-113	-127
	1000	3,183,201	-117	-226	-254
	2000	3,183,201	-234	-452	-508
Scenario 2[b]	500	3,183,201	-146	-502.5	-878
	1000	3,183,201	-292	-1005	-1756
	2000	3,183,201	-584	-2010	-3512

Source: 2010 IMPLAN county data files (baseline conditions) and IMPLAN model runs for LSJR alternatives; Appendix L, *City and County of San Francisco Analyses,* Table L.6-3 and L.6-5.

$/AF = dollars per acre-foot.

[a] Scenario 1 is defined in Appendix L as: storage credits would be reallocated only if CCSF has a positive credit balance in the water bank account.

[b] Scenario 2 is defined in Appendix L as: storage credits would be reallocated even if CCSF has a negative balance in the water bank account.

[c] Region consists of the four Bay Area counties: San Francisco, Alameda, San Mateo, and Santa Clara

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood to change economic effects as it would allow the unimpaired flow requirement to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow). For LSJR Alternative 2 an increase from 20 percent to 30 percent of the unimpaired flow would likely result in different effects as compared to those shown above for LSJR Alternative 2, depending upon flow conditions and frequency of the adjustment. As such, under LSJR Alternatives 2 or 3, if the percentage of unimpaired flow is increased with adaptive implementation method 1, water supply costs to water districts served by the SFPUC also would likely increase as these districts develop more costly water supply options than those developed without adaptive implementation. On the other hand, under LSJR Alternatives 3 and 4, if the percent of unimpaired flow is reduced with adaptive implementation method 1, water supply costs to SFPUC and affected water districts would be somewhat less than expected without adaptive implementation. Overall, the costs to the SFPUC associated with replacing reduced water supplies from the Tuolumne River Watershed would be expected to increase as the deliveries are reduced.

20.3.4 Effects on Hydropower Generation, Revenues and the Regional Economy

Introduction

The analysis in this section, as explained in Appendix J, *Hydropower and Electric Grid Analysis of Lower San Joaquin River Flow Alternatives*, discusses the potential effects of LSJR Alternatives 2, 3, and 4 for hydropower generation on the three eastside tributaries and the corresponding effects on revenue generation. Implementation of the LSJR alternatives could change reservoir operations, which, in turn, could alter the associated timing of water releases and amount of hydropower generated from hydroelectric facilities on the eastside tributaries. The study area for analyzing hydropower generation includes the three rim dams[7] on the eastside tributaries: New Melones on the Stanislaus River, New Don Pedro on the Tuolumne River, and New Exchequer on the Merced River. The study area also includes areas where connecting transmission systems are located and areas where the balancing authorities for the three hydropower plants—New Melones, New Don Pedro, and New Exchequer—are located, as described in Appendix J, Section J.1 and J.3.

The remaining discussion is organized around a description of baseline conditions and potential effects of each LSJR alternative. The analysis focuses on three related topics: the amount of hydropower generated, generation-related revenues, and effects on regional economic conditions, including ratepayers. Information on hydropower generation and related revenues is presented by tributary area and by hydropower facility. The methods used to assess these related topics are described first.

Assessment Methods

Results from the WSE model provides estimates of the effects of LSJR Alternatives 2, 3, and 4 on reservoir releases and storage (elevations head) and on allowable diversions to off-stream generation facilities; these results are used in this analysis to estimate changes in the generation of monthly and annual amounts of hydropower associated with LSJR Alternatives 2, 3, and 4. It should be noted that changes in hydropower generation at each rim dam differ from changes in total hydropower generation by tributary because other hydroelectric facilities on the tributaries may also contribute to the amount of hydropower generated.

In addition to changes in hydropower generation under LSJR Alternatives 2, 3, and 4, revenues associated with these changes in hydropower generation also are estimated. To derive the effects of LSJR Alternatives 2, 3, and 4 on hydropower revenue, the estimated change in monthly power generated over the 82-year simulation period is multiplied by an assumed monthly price of hydropower.

The monthly price of power used in the assessment is the value at the 80th percentile of average hourly power prices (i.e., the value at which 80 percent of the hourly prices were lower); monthly values available from the California Independent System Operators (ISO) during the 2006 calendar year were used in the assessment. Prices for 2006 were used because, as shown in Figure 20.3.4-1 below, these prices most closely match the median price during years in which price data are

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[7] In this document, the term *rim dams* is used when referencing the three major dams and reservoirs on each of the eastside tributaries: New Melones Dam and Reservoir on the Stanislaus River; New Don Pedro Dam and Reservoir on the Tuolumne River; and New Exchequer Dam and Lake McClure on the Merced River.

available (1998 to 2008.) The 2006 monthly prices (Table 20.3.4-1) were adjusted to 2008 dollars using *Engineering News-Record* (*ENR*) Building Cost Indices.[8] Note that the use of monthly power prices at the 80th percentile of hourly prices is considered a conservative approach to estimating hydropower revenue impacts because historical power prices have been generally lower than this 80th percentile value. As a result, the estimated revenue impacts of LSJR Alternatives 2, 3, and 4 likely overstate, to some limited extent, the actual effects on hydropower generation revenue.

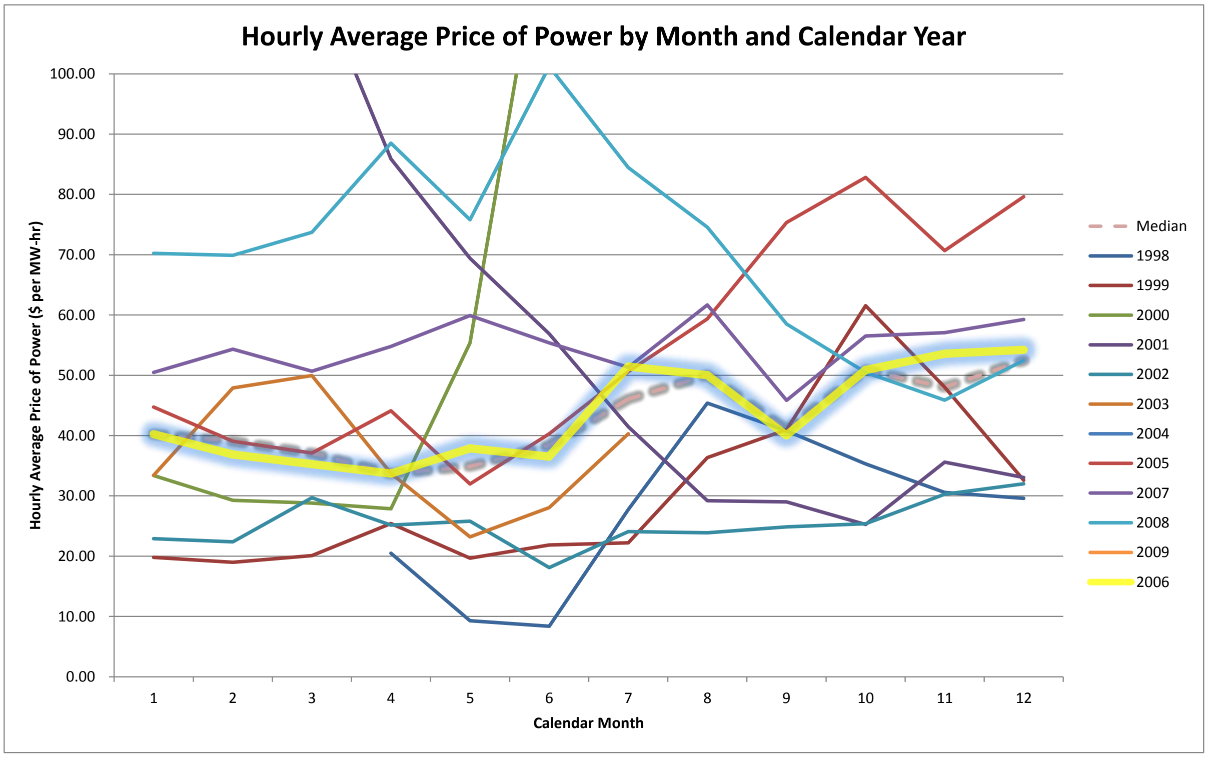

Figure 20.3.4-1. Monthly Average Price and Median Monthly Average Price of Power 1998–2008

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[8] The *ENR* Building Cost Index, which has been issued since 1915, is widely used throughout the U.S. construction industry as a benchmark for measuring inflation.

Table 20.3.4-1. Selected 80th Percentile of Hourly Prices from 2006 and Factors used to Escalate to 2008 Dollars

	2006 ISO Power Price	Building Cost Index Adjustment Factor	ISO Power Price Adjusted by Building Cost Index Factor
Calendar Month	$/MWh ($2006)		$/MWh ($2008)
1	56.46	1.0900	61.54
2	47.86	1.0886	52.11
3	43.81	1.0927	47.87
4	47.48	1.0934	51.92
5	51.83	1.0938	56.69
6	54.31	1.0949	59.46
7	61.49	1.0912	67.10
8	61.22	1.0896	66.70
9	51.25	1.0891	55.82
10	58.63	1.0456	61.30
11	63.76	1.0404	66.34
12	64.31	1.0435	67.11

Note: The 2006 ISO power price is the 80th percentile of hourly prices within each month during the 2006 calendar year. The 2006 prices were adjusted to 2008 dollars using the *Engineering News-Record* Building Cost Index.

ISO = Independent System Operators

$/MWh ($2006) = dollars per megawatt hour in 2006 dollars$/MWh ($2008) = dollars per megawatt hour in 2008 dollars

Hydropower Generation

Table 20.3.4-2 shows the average annual hydropower generation on the three eastside tributaries under baseline conditions and the relative change associated with each of the LSJR alternatives. Under baseline conditions, hydropower generation plants on the tributaries are estimated to produce 1,650 gigawatt hours (GWh) of energy per year, with 35 percent from facilities on the Stanislaus River, 40 percent from facilities on the Tuolumne River, and 25 percent from facilities on the Merced River. Under LSJR Alternative 2, energy production increases relative to baseline for all three tributaries, but as the unimpaired flow requirements increase under LSJR Alternatives 3 and 4, the amount of power generated annually is reduced. Relative to baseline, total annual hydropower generation on the tributaries increases by 29 GWh under LSJR Alternative 2, decreases by 4 GWh under LSJR Alternative 3, and decreases by 87 GWh under LSJR Alternative 4.

The analysis presented in Appendix J, *Hydropower and Electric Grid Analysis of Lower San Joaquin River Flow Alternatives*, and summarized here, also estimates the amount of hydropower that would be generated at the major rim dam facilities on each of the three eastside tributaries. Table 20.3.4-3 shows the average annual hydropower generation at each of the three rim dam facilities under baseline conditions and the relative change associated with each of the LSJR alternatives. Under baseline conditions, hydropower facilities at the three rim dams are estimated to produce 1,318 GWH per year. New Don Pedro on the Tuolumne River generates the most energy at about 604 GWh annually (46 percent of the total), while New Melones and New Exchequer generate 419 GWh (32 percent of the total) and 295 GWh (22 percent of the total), respectively. Overall energy production at the three rim dams increases relative to baseline under LSJR Alternatives 2 and 3, but the increase diminishes as the unimpaired flow requirement gets larger under LSJR Alternative 3. Under LSJR Alternative 4, hydropower facilities at the three rim dams generate less total power than under baseline conditions, but facilities at New Melones generate slightly more. Relative to baseline, total annual hydropower generation at the rim dams increases by 38 GWh under LSJR Alternative 2 and by 18 GWh under LSJR Alternative 3, but decreases by 33 GWh under LSJR Alternative 4.

Table 20.3.4-2. Average Annual Baseline Hydropower Generation and Difference from Baseline, by Tributary

Alternative	Stanislaus (GWh)	Tuolumne (GWh)	Merced (GWh)	All Tributaries (GWh)
Baseline	586	656	408	1,650
LSJR Alternative 2	18	2	8	29
LSJR Alternative 3	4	-6	-3	-4
LSJR Alternative 4	-23	-41	-23	-87

Note: Numbers are rounded.

GWh = gigawatt hours

Table 20.3.4-3. Average Annual Baseline Hydropower Generation in New Melones, New Don Pedro, and New Exchequer Hydropower Facilities and Difference from Baseline, by Facility

Alternative	New Melones (GWh)	New Don Pedro (GWh)	New Exchequer (GWh)	Three Facilities (GWh)
Baseline	419	604	295	1,318
LSJR Alternative 2	+22	+2	+13	+38
LSJR Alternative 3	+14	-4	+8	+18
LSJR Alternative 4	+2	-33	-2	-33

Note: Numbers are rounded.

GWh = gigawatt hours

Hydropower Generation-Related Revenue

Table 20.3.4-4 shows the average annual hydropower revenue on each of the three tributaries under baseline conditions and the relative change associated with each of the LSJR alternatives. Under baseline conditions, total revenue from energy production on the three tributaries is estimated to be $97.5 million per year, with 36 percent from facilities on the Stanislaus River, 39 percent from facilities on the Tuolumne River, and 25 percent from facilities on the Merced River. Under the LSJR Alternatives 2, 3, and 4, the change in revenue from hydropower generation on each of the tributaries is proportional to the change in hydropower generation. Relative to baseline, total annual hydropower revenue over all there tributaries increases by $1.7 million under LSJR Alternative 2, decreases by $0.67 million under LSJR Alternative 3, and decreases by $6.5 million under LSJR Alternative 4. Under LSJR Alternative 2, facilities on the Tuolumne River have the smallest revenue increase, whereas the Tuolumne River facilities have the greatest revenue decrease under LSJR Alternatives 3 and 4.

Table 20.3.4-5 shows the average annual hydropower revenue produced by facilities at each of the rim dams on the three tributaries under baseline conditions and the relative change associated with each of the LSJR alternatives. Under baseline conditions the total revenue from energy production by facilities at all three rim dams is estimated to be $77.8 million per year. Facilities at New Don Pedro on the Tuolumne River produce the most revenue, accounting for $35.4 million annually (46 percent of the total), whereas facilities at New Melones and New Exchequer annually contribute $24.8 million (32 percent of the total) and $17.6 million (22 percent of the total), respectively. Overall, revenue from energy production at facilities at the rim dams increases relative to baseline under LSJR Alternatives 2 and 3, but the increase diminishes as the unimpaired flow requirement gets larger under LSJR Alternative 3. Relative to baseline , annual revenues from the sale of hydropower generated at the rim dams is estimated to increase by $2.2 million under LSJR Alternative 2, increase by $0.72 million under LSJR Alternative 3, and decline by $3.2 million under LSJR Alternative 4.

Table 20.3.4-4. Average Annual Baseline Hydropower Revenue and Difference from Baseline, by Tributary

Alternative	Stanislaus ($)	Tuolumne ($)	Merced ($)	All Tributaries ($)
Baseline	34,711,954	38,509,568	24,288,834	97,510,355
LSJR Alternative 2	1,107,615	107,213	464,967	1,679,795
LSJR Alternative 3	139,363	-479,990	-329,987	-670,613
LSJR Alternative 4	-1,866,071	-2,916,944	-1,765,366	-6,548,380

Note: Revenues shown in 2008 dollars.

Table 20.3.4-5. Average Annual Baseline Hydropower Revenue from New Melones, New Don Pedro, and New Exchequer Hydropower Facilities and Difference from Baseline, by Facility

Alternative	New Melones ($)	New Don Pedro ($)	New Exchequer ($)	Three Facilities ($)
Baseline	24,798,903	35,436,787	17,563,111	77,798,801
LSJR Alternative 2	1,338,481	92,113	782,483	2,213,076
LSJR Alternative 3	738,473	-387,781	377,854	728,546
LSJR Alternative 4	-319,743[a]	-2,414,141	-440,110	-3,173,994

Note: Revenues shown in 2008 dollars.

[a] An increase or decrease in revenue that is contrary to the direction of change in average hydropower generation is explained by the shift in power generation over the year from a lower price to a higher price. Although the overall generation is lower (or higher), the change in price leads to higher (or lower) revenue (e.g., shifting an equal generation January–April to June–October would result in increased revenue due to higher prices charged for energy).

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood of changing economic effects as it would allow the unimpaired flow requirements to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow). For LSJR Alternative 2 an increase from 20 percent to 30 percent of the unimpaired flow would likely result in different effects as compared to those shown above for LSJR Alternative 2, depending upon flow conditions and frequency of the adjustment. As such, under LSJR Alternatives 2 or 3, if the percentage of unimpaired flow is increased with adaptive implementation method 1, hydropower revenue could be slightly less than is predicted without adaptive implementation. On the other hand, under LSJR Alternatives 3 and 4, if the percent of unimpaired flow is reduced with adaptive implementation method 1, hydropower revenue could be slightly higher than predicted without adaptive implementation.

In addition, adaptive implementation methods 2 and 3 could also affect hydropower generation, given that hydropower generation is affected by the timing of reservoir releases. Method 2 involves shifting flow between months within the February–June period to improve conditions for fish and wildlife, whereas method 3 involves shifting flow from February–June to later in the year to prevent negative impacts for fisheries. Under both methods for all LSJR alternatives, shifting the timing of reservoir releases could produce small changes in revenue as a result of the fluctuating value of power generation. Changes in reservoir storage levels as a result of adaptive implementation could also affect hydropower generation. For example, retaining water until later in the February – June time frame or until fall, will keep reservoir storage higher for a longer amount of time and thereby increase hydropower generation. However, adaptive implementation is not expected to substantially affect revenues related to hydropower generation.

Baseline Regional Economy Conditions and Potential Regional Effects Related to Hydropower

This section qualitatively evaluates potential regional economic effects associated with predicted changes in hydropower generation and associated revenues under LSJR Alternatives 2, 3, and 4. Predicted changes in hydroelectric power generation could potentially affect residents statewide in terms of electricity rates; however, modeling results presented in Tables 20.3.4-2 and 20.3.4-3 above suggest that the changes in energy generation would be virtually imperceptible at the statewide level.

Potential impacts on the regional economy caused by changes in hydropower generation can be evaluated by describing the underlying relationship between changes in hydropower production and regional economic conditions. From the perspective of the statewide electricity grid, power lost as a result of implementing one of the LSJR alternatives would need to be replaced to meet statewide electricity demand, especially during peak summer months. Presumably, purchasing replacement power from other sources would be more costly to power utilities than purchasing power from hydropower facilities on the three tributaries. Electricity providers could offset the cost of purchasing replacement power by raising utility rates for residential, commercial, and industrial users. For these users, increased spending on higher electricity bills could cause reduced spending on other goods and services, in turn, causing some employment and revenue losses for certain sectors of the state's economy. The extent of these effects would depend on the size of the hydropower losses relative to California's overall supply of electricity.

Hydropower generation on the eastside tributaries under LSJR Alternatives 2, 3, and 4 is estimated to increase by 29 GWh under LSJR Alternative 2, decrease by 4 GWh under LSJR Alternative 3, and decrease by 87 GWh under LSJR Alternative 4 (Table 20.3.4-2). According to the California Energy Commission (2012), California's electricity generating system annually produces more than 296,000 GWh, accounting for 69 percent of the electricity the state uses. Compared to annual statewide electricity production, the hydropower changes potentially caused by one of the LSJR alternatives would range from an increase of less than 0.0001 percent under LSJR Alternative 2 to a reduction of about 0.0003 percent under LSJR Alternative 4. Thus, the impacts of the LSJR alternatives on hydropower related revenues are relatively small and would not likely affect ratepayers in any substantial way. In addition, given the virtually imperceptible effects at a regional and statewide level under each of the LSJR alternatives, adaptive implementation is not expected to have an effect on regional hydropower generation or revenue.

20.3.5 Effects on Fisheries and Associated Regional Economies

Introduction

This section addresses potential economic effects concerning commercial and sport fisheries, with a specific emphasis on Chinook salmon, which could be affected by implementation of the LSJR alternatives. Because biological impacts on fishery resources, such as expected population shifts for key fish species (e.g., Chinook salmon), are highly uncertain and difficult to quantify, the corresponding economic effects also are difficult to evaluate. As a result, this analysis of fisheries-related economic effects is necessarily qualitative.

The study area for this analysis includes areas where there is commercial and sport fishing activity for species that could be affected by the LSJR alternatives. This not only includes the rim reservoirs and three eastside tributaries, but also the greater Bay-Delta region and the more expansive Pacific Ocean, plus coastal fishing areas along the western United States.

As discussed in Chapter 7, *Aquatic Biological Resources*, improving flow conditions in the SJR Watershed to the Delta at Vernalis can be expected to benefit many native fishes. However, relevant information on potential effects on native species is too limited to estimate exact population responses to habitat improvements. It is likely, however, that LSJR Alternatives 2, 3, and 4 would benefit many native plant and animal species (Merz and Moyle 2006) that exist in and adjacent to the Stanislaus, Tuolumne, and Merced Rivers through increased availability of marine derived nutrients and through improved habitat (e.g., riparian and floodplain) conditions. Information is too limited, however, to predict the exact expected positive biological responses and then to assign an appropriate economic value to those responses.

Because information on potential effects on native fish species is limited, a case study approach that focuses on Chinook salmon, a key fish species expected to benefit substantially from LSJR Alternatives 2, 3, and 4, is instructively used to examine potential economic effects associated with aquatic habitat improvements. Although results from evaluating the biological impacts of LSJR Alternatives 2, 3, and 4 on Chinook salmon populations also are limited, historical population and harvest information concerning Chinook salmon are available; this information is used to provide some insight into potential monetary values associated with improving salmon habitat in the three eastside tributaries.

Potential benefits to native fish populations such as Chinook salmon would be expected at spatial scales that extend beyond the plan area. For example, there is the potential to improve the population resiliency and stability to Central Valley fish populations by improving SJR fish populations (Carlson and Satterthwaite 2011).

This section is organized by first presenting relevant background information, including information on game species and associated sport fishing activity, on salmon management and harvest in the study area, and on recent salmon fishery closures in California. This discussion is followed by an assessment of the effects of LSJR Alternatives 2, 3, and 4 on commercial and sport fisheries, focusing on Chinook salmon. The section describes the potential economic effects on use and non-use (passive use) values associated with improving habitat conditions and sustaining salmon populations, and addresses potential effects on the regional economies affected by commercial and sport fishing activity.

Background Fishery Conditions

This section describes historical and recent information on commercial and sport fisheries that could be affected by the plan amendments. Unlike other topics covered in this chapter, the information presented here is not referred to as a baseline, primarily because these conditions characterize historical information, trends, and other dynamic factors that do not serve as an specific point of reference. Overall, there is too much uncertainty concerning the many factors that affect fishery conditions (e.g., population conditions, management actions, harvest rates) to establish a point of reference (or baseline) for evaluating potential effects. This background section describes game and sport fishing activities, salmon management actions, commercial harvest levels, and recent salmon fishery closures within the study area.

Game Species and Sport Fishing Activity

Fishing is a common recreational activity on the rivers and reservoirs of the plan area. As discussed in greater detail in Chapter 7, *Aquatic Biological Resources*, the mainstem LSJR and three eastside tributaries support several warmwater game fish populations, such as smallmouth and largemouth bass, sunfish, and catfish, as well as a variety of native fishes, such as hardhead, Sacramento pikeminnow, Sacramento sucker, sculpin, and lamprey. The mainstem LSJR and the three eastside tributaries also provide habitat for coldwater species, such as trout and Chinook salmon. Historically, the Upper SJR supported abundant populations of spring- and fall-run Chinook salmon and steelhead. Today, however, only small populations of fall-run Chinook salmon and steelhead are found in the three eastside tributaries.

Among the many game fish in the mainstem LSJR and its tributaries (refer to Chapter 7*, Aquatic Biological Resources*), the most commonly caught by sport anglers are as follows.

- LSJR: largemouth bass, striped bass, catfish, and sunfish.
- Stanislaus River: striped bass, largemouth bass, smallmouth bass, American shad, and rainbow trout.
- Tuolumne River: American shad, largemouth bass, smallmouth bass, striped bass, catfish, and sunfish.

- Merced River: largemouth bass, smallmouth bass, American shad, catfish, and sunfish.

The tributary reservoirs support a variety of fish species, including rainbow trout, brown trout, largemouth bass, smallmouth bass, kokanee, catfish, and sunfish. Sport anglers typically fish from the shore or boats for the following species in tributary reservoirs.

- New Don Pedro Reservoir: kokanee, Chinook salmon, brown trout, brook trout, rainbow trout, largemouth bass, smallmouth bass, spotted bass, catfish, and sunfish.
- New Melones Reservoir: rainbow trout, brown trout, kokanee, largemouth bass, smallmouth bass, catfish, and sunfish.
- Lake McClure: kokanee, rainbow trout, Chinook salmon, largemouth bass, spotted bass, catfish, and sunfish.

Historical (1990s and early 2000s) estimates of fishing activity at major recreation areas (rivers and reservoirs) within tributary Watersheds are identified in Section 20.3.6, *Effects on Recreational Oportunities, Activity, and the Regional Economy* (Table 20.3.6-1). As shown, sport fishing activity on the tributaries are approximated to be 5,200 angler days annually along the Lower Stanislaus River and 34,900 angler days annually along the Lower Tuolumne River; no fishing-specific estimates are available for the Merced River. Annual sport fishing activity on the LSJR is approximated at 57,500 angler days.

Salmon Management and Harvest in the Study Area

This section describes salmon management and harvest conditions in the study area. As noted above, the study area includes geographic areas where commercial and sport fishing activity occurs that could be affected by salmon production in the three eastside tributaries.

Ocean Salmon Fisheries in the Pacific Region

Ocean commercial and recreational fishing for salmon originating from Central Valley rivers occurs along the California coast, primarily from Monterey north to central Oregon. Salmon harvest levels for ocean and river fisheries are managed by federal and state agencies. The Pacific Fisheries Management Commission (PFMC) coordinates this process and annually assesses salmon populations to establish sustainable salmon harvest levels for the Pacific Region (California, Oregon, and Washington). The PFMC also sets ocean commercial and recreational fishing seasons for harvesting of salmon in federal waters. Each year, the PFMC recommends ocean fishing regulations designed to meet constraints established by escapement goals and jeopardy opinions for federally listed species. California fisheries are managed, in part, to meet escapement, allocation, and rebuilding goals for Klamath River fall-run Chinook salmon, coastal natural spawning coho salmon, and Sacramento River spring-, fall-, and winter-run Chinook salmon (Boydstun 2001).

In the Pacific region, salmon fisheries are subject to weak stock management, where access to the harvestable surplus of healthier stocks is often restricted to protect weaker stocks with which they co-mingle in the ocean. This makes establishing regulations difficult. For example, in 2008 and 2009 (see *Recent Salmon Fishery Closures in California* section below), virtually all fishing in the ocean off California was closed to protect Central Valley fall-run Chinook, even though Klamath fall-run Chinook salmon returns were large enough to support limited ocean angling (Morse and Manji 2009). Salmon management is further complicated by the need to ensure equitable allocation of harvest among diverse user groups and the need to coordinate with the entities that have jurisdiction over other aspects of salmon management. The PFMC also develops a catch-sharing plan for tribal and non-tribal fisheries conducted in federal waters (NMFS 2014).

Historically, Native American tribes along the West Coast relied on natural resources as a source of food, nutrients, and trading commodities. Over time, the opportunity to engage in traditional use fisheries has been dramatically limited by political forces and human population expansion. Native American natural resource initiatives along the West Coast have resulted in an array of contemporary outcomes, including the sometimes controversial Boldt Decision in the Pacific Northwest (Norman et al. 2007). For California state-managed waters (i.e., those extending 3 nautical miles offshore), the California Fish and Game Commission (Commission) establishes salmon fishing regulations to ensure that California's non-tribal harvest allowances are not exceeded by commercial fishers and recreational anglers.

The California Department of Fish and Wildlife (CDFW), as the state fishery management agency, manages fishery regulations, implements management plans, provides technical expertise, and coordinates the implementation of policy throughout California. CDFW is responsible for providing recommendations to the Commission and for carrying out research that informs these recommendations or other management decisions to be made by the California State Legislature. All of these regulations affect recreational and commercial fishing opportunities and, therefore, the economic value of these fisheries in California (Morse and Manji 2009).

Historical Harvest of Ocean Commercial and Sport Salmon in California

Ocean commercial harvest levels for Chinook salmon in California have varied considerably over the last four decades, as shown in Table 20.3.5-1. Excluding the fishery closure years of 2008 and 2009 (see *Recent Salmon Fishery Closures in California* section below), statewide commercial salmon catch between 1976 and 2013 varied from about 1,317,200 salmon in 1988 down to 15,100 salmon in 2010. During this period, catches could change substantially from year to year. The best 5-year period occurred from 1986–1990, with an average of 794,700 fish caught per year.

Table 20.3.5-1. California Commercial Troll Chinook Salmon Landings (in number of fish) and Prices by Catch Area, 1976–2014

	Catch Area						Price Per Pound	
Year	Crescent City	Eureka	Fort Bragg	San Francisco	Monterey	Statewide	Nominal	Adjusted 2014 $[a]
1976	20,971	165,419	115,683	138,231	99,626	539,930	NA	NA
1977	36,285	161,175	138,886	185,164	78,675	600,185	NA	NA
1978	59,636	155,168	131,854	158,158	132,842	637,658	NA	NA
1979	71,783	218,363	202,467	180,087	54,060	726,760	$2.53	$6.27
1980	32,622	131,283	130,443	211,778	82,524	588,650	$2.27	$5.15
1976–1980 Average	**44,259**	**166,282**	**143,867**	**174,684**	**89,545**	**618,637**	**$2.40**	**$5.71**
1981	81,821	99,709	116,624	199,910	89,995	588,059	$2.25	$4.67
1982	73,317	95,654	170,049	289,462	136,678	765,160	$2.55	$4.99
1983	24,686	35,177	55,886	75,019	103,215	293,983	$2.09	$3.93
1984	14,369	13,979	49,751	167,668	53,992	299,759	$2.67	$4.84
1985	0	0	153,980	175,681	36,637	366,298	$2.56	$4.51
1981–1985 Average	**38,839**	**48,904**	**109,258**	**181,548**	**84,103**	**462,652**	**$2.42**	**$4.59**
1986	13,976	36,738	272,418	302,302	200,154	825,588	$2.01	$3.46
1987	33,535	54,737	341,216	355,615	91,231	876,334	$2.78	$4.65
1988	15,619	46,414	424,663	642,693	187,818	1,317,207	$2.86	$4.63
1989	5,470	17,467	144,229	255,817	107,955	530,938	$2.39	$3.73
1990	1,386	6,289	79,553	199,147	137,072	423,447	$2.77	$4.16
1986–1990 Average	**13,997**	**32,329**	**252,416**	**351,115**	**144,846**	**794,703**	**$2.56**	**$4.13**
1991	0	4,700	35,600	174,800	79,800	294,900	$2.58	$3.74
1992	0	0	-	95,800	64,500	160,300	$2.74	$3.88
1993	0	0	19,891	154,999	104,663	279,553	$2.25	$3.12
1994	0	0	5,210	219,856	70,508	295,574	$2.07	$2.81
1995	0	0	8,714	357,486	313,112	679,312	$1.76	$2.34
1991–1995 Average	**0**	**940**	**17,354**	**200,588**	**126,517**	**341,928**	**$2.28**	**$3.18**
1996	254	8,821	22,930	167,379	181,467	380,851	$1.44	$1.88
1997	0	1,424	3,776	253,484	228,731	487,415	$1.38	$1.77
1998	0	2,501	2,882	126,120	95,433	226,936	$1.66	$2.10
1999	125	2,375	2,283	180,960	78,709	264,452	$1.93	$2.41
2000	251	1,776	30,773	250,368	197,184	480,352	$2.01	$2.46
1996–2000 Average	**126**	**3,379**	**12,529**	**195,662**	**156,305**	**368,001**	**$1.68**	**$2.12**

	Catch Area						Price Per Pound	
Year	Crescent City	Eureka	Fort Bragg	San Francisco	Monterey	Statewide	Nominal	Adjusted 2014 $[a]
2001	223	5,300	14,993	136,630	35,940	193,086	$1.98	$2.56
2002	4,459	9,008	65,336	242,872	69,980	391,655	$1.55	$1.98
2003	3,356	688	248,875	202,876	36,099	491,894	$1.91	$2.39
2004	26,220	5,695	107,259	298,229	64,707	502,110	$2.87	$3.49
2005	1,255	5,799	45,869	170,531	117,408	340,862	$2.97	$3.50
2001–2005 Average	**7,103**	**5,298**	**96,466**	**210,228**	**64,827**	**383,921**	**$2.26**	**$2.78**
2006	0	0	10,835	47,689	11,204	69,728	$5.13	$5.87
2007	2,367	6,395	16,116	75,254	14,009	114,141	$5.18	$5.77
2008	NA	NA	NA	NA	NA	NA	NA	NA
2009	NA	NA	NA	NA	NA	NA	NA	NA
2010	0	0	12,553	1,105	1,430	15,088	$5.47	$5.86
2006–2010 Average[b]	**789**	**2,132**	**13,168**	**41,349**	**8,881**	**66,319**	**$5.26**	**$5.83**
2011	417	1,974	39,311	21,912	6,414	70,028	$5.18	$5.44
2012	400	4,831	38,211	118,570	52,796	214,808	$5.34	$5.51
2013	1,225	8,953	116,158	143,654	27,637	297,627	$6.23	$6.33
2014	17	596	76,801	81,506	7,566	166,486	$5.54	$5.54
1976–2014 Average[b]	**14,217**	**35,362**	**95,891**	**190,779**	**93,291**	**426,949**	**$2.91**	**$3.99**

Sources: Pacific Fishery Management Council 1997, 2013, 2014, 2015 (Tables A-3 and IV-2).

NA = not available. Note that the commercial salmon fishery was closed in 2008 and 2009.

[a] Nominal prices adjusted to 2014 dollars using the gross domestic product implicit price deflator.

[b] Averages exclude the salmon fishery closure years of 2008 and 2009.

Compared to the 1976–2014 average annual harvest of 426,900 salmon, commercial harvests between 1976 and 1990 were relatively high, averaging 625,300 fish per year. However, commercial harvests then dropped to an average of 364,600 fish from 1990 until 2005, and then further declined to an average of 67,200 fish per year from 2006–2011, excluding 2008 and 2009 when fisheries were closed. Although more recent harvests have shown large improvements, average harvests from 2012 to 2014 were still 47 percent below the 37-year (1976–2014, excluding 2008 and 2009) average. Commercial landings in the San Francisco port area accounted for 45 percent of statewide landings over the 37-year period, followed by the Monterey (22 percent), and Fort Bragg (22 percent) port areas (Table 20.3.5-1). The remainder of the statewide salmon catch was landed in the Eureka (8 percent) and Crescent City (3 percent) port areas. However, annual harvests vary significantly for all ports.

As can be seen by reviewing the harvest data in Table 20.3.5-1, Chinook salmon harvests in the Crescent City and Eureka port areas, and to a lesser extent in the Fort Bragg port area, were eliminated or greatly reduced from 1991–2001. For these port areas, stringent commercial fishing regulations have been imposed in some years to protect Klamath River fall-run Chinook in the PFMC's Klamath Management Zone (KMZ) (encompassing Curry County in Oregon and Humboldt and Del Norte counties in California). By severely constraining harvest in the KMZ, the PFMC is able to maintain fishing opportunities in other areas farther from the KMZ (e.g., San Francisco, Monterey) that have lesser impacts on this stock (Pomeroy et al. 2010). Additionally, the California portion of the KMZ was closed to commercial salmon fishing from 1992–1995 due to several localized factors. These factors include the need to protect Oregon Coastal Natural coho, a determination that the Klamath fall-run Chinook had been overfished, and a court decision allocating 50 percent of Klamath-Trinity River salmon to the Yurok and Hoopa tribes (Pomeroy et al. 2010). Finally, in 2006, failure of Klamath fall-run Chinook to achieve established escapement minimums for the third consecutive year prompted the PFMC to close the commercial fishery in the California KMZ and curtail the season in other areas (Pomeroy et al. 2011). Until recently, Klamath River fall-run Chinook was the constraining stock in the ocean fishery, prompting the restrictive regulations. Since 2007, however, conservation concerns regarding Sacramento River fall-run Chinook have prompted unprecedented recreational season reductions and closures statewide (see *Recent Salmon Fishery Closures in California* section below [Pomeroy et al. 2010]).

In inflation-adjusted 2014 dollars, ex-vessel prices[9] for Chinook salmon averaged $3.99 per pound between 1979 and 2014 (Table 20.3.5-1). Annual inflation-adjusted salmon prices were above $3.00 every year through 1993. From 1994 through 2003, however, average prices did not exceed the 1994 value of $2.81. After 2003, prices rebounded and have not fallen below an inflation-adjusted $3.49 through 2014. The 1979–2014 overall inflation-adjusted average price of $3.99 was exceeded in every year since 2005 (excluding 2008 and 2009 when the California commercial salmon fishery was closed). The 2014 average inflation-adjusted price of $5.54 was 39 percent above the average between 1979 and 2014.

Similar to commercial harvests, ocean sport (or recreational) catch has varied substantially from year to year. Excluding the complete or partial closure years of 2008 and 2009 (see *Recent Salmon Fishery Closures in California* section below), statewide ocean sport catch of Chinook salmon between 1976 and 2014 ranged from 397,200 fish in 1995 to 14,800 fish in 2010, averaging about 128,200 fish per year over the entire period (Table 20.3.5-2). During that time, the best 5-year period for sport catch occurred from 1991–1995, with an average catch of approximately 170,300 salmon per year.

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[9] The *ex-vessel price* is a measure of the dollar value of commercial landings, usually calculated as the price per pound at first purchase of the commercial landings multiplied by the total pounds landed.

Table 20.3.5-2. California Ocean Recreational Chinook Salmon Landings (in number of fish) by Catch Area, 1976–2014

	Catch Area					
Year	Crescent City	Eureka	Fort Bragg	San Francisco	Monterey	Statewide
1976	2,991	7,111	2,324	63,760	4,807	80,993
1977	7,400	13,261	6,323	72,594	4,006	103,584
1978	1,986	2,308	2,534	64,085	1,809	72,722
1979	2,879	3,647	4,626	102,547	5,929	119,628
1980	2,718	4,046	1,308	73,093	4,020	85,185
1976–1980 Average	**3,595**	**6,075**	**3,423**	**75,216**	**4,114**	**92,422**
1981	4,007	4,406	1,787	70,084	3,743	84,027
1982	6,196	7,084	2,948	116,910	5,586	138,724
1983	3,445	5,484	1,933	49,717	3,243	63,822
1984	3,523	4,611	999	73,233	5,437	87,803
1985	17,989	26,384	4,985	112,475	9,276	171,109
1981–1985 Average	**7,032**	**9,594**	**2,530**	**84,484**	**5,457**	**109,097**
1986	5,760	10,459	10,584	86,255	28,558	141,616
1987	12,060	18,436	9,201	119,526	33,320	192,543
1988	17,236	14,345	9,406	114,455	15,919	171,361
1989	25,275	24,642	5,803	93,659	37,248	186,627
1990	12,717	11,109	3,388	77,562	35,053	139,829
1986–1990 Average	**14,610**	**15,798**	**7,676**	**98,291**	**30,020**	**166,395**
1991	3,367	9,508	5,854	37,274	24,830	80,833
1992	889	1,706	4,263	47,193	19,526	73,577
1993	1,272	3,614	5,821	78,733	20,584	110,024
1994	6,321	3,664	14,018	140,977	24,835	189,815
1995	5,556	8,075	29,048	155,677	198,875	397,231
1991–1995 Average	**3,481**	**5,313**	**11,801**	**91,971**	**57,730**	**170,296**
1996	3,828	6,919	24,002	84,471	44,812	164,032
1997	2,527	6,456	11,584	123,974	84,427	228,968
1998	1,123	1,790	4,663	70,969	43,468	122,013
1999	1,016	5,175	5,263	69,251	7,140	87,845
2000	3,571	9,903	25,942	64,653	81,782	185,851
1996–2000 Average	**2,413**	**6,049**	**14,291**	**82,664**	**52,326**	**157,742**
2001	2,236	10,588	26,064	39,856	20,039	98,783
2002	1,107	15,024	31,202	87,008	47,703	182,044
2003	391	8,361	16,180	56,616	13,126	94,674
2004	1,290	21,554	23,205	130,220	44,845	221,114
2005	1,498	16,046	22,183	72,824	30,706	143,257
2001–2005 Average	**1,304**	**14,315**	**23,767**	**77,305**	**31,284**	**147,974**

	Catch Area					
Year	Crescent City	Eureka	Fort Bragg	San Francisco	Monterey	Statewide
2006	756	15,647	13,993	54,926	10,970	96,292
2007	871	18,025	5,751	16,796	6,261	47,704
2008	-	-	6	-	-	6
2009	147	525	-	-	-	672
2010	0	720	1,678	6,116	6,295	14,809
2006–2010 Average[a]	**542**	**11,464**	**7,141**	**25,946**	**7,842**	**52,935**
2011	113	9,874	7,398	19,734	12,703	49,822
2012	7,432	32,012	7,929	46,189	30,364	123,926
2013	6,063	27,918	10,168	61,291	10,634	116,074
2014	3233	12,594	12,540	32,359	14,020	74,746
1976–2014 Average[a]	**4,882**	**10,879**	**10,186**	**75,326**	**26,916**	**128,189**

Sources: Pacific Fishery Management Council 2013, 2014, 2015 (Table A-5).

[a] Averages exclude the salmon fishery closure years of 2008 and 2009.

Sport landings from the San Francisco catch area accounted for almost 60 percent of statewide ocean sport landings over the 37-year period (i.e., excluding 2008 and 2009), followed by the Monterey area (21 percent) (Table 20.3.5-2). Sport landings in the Crescent City, Eureka, and Fort Bragg areas, which accounted for 19 percent of statewide ocean sport landings over the period, have been affected by many of the same management considerations that have restricted commercial salmon harvests.

According to historical data maintained by the U.S. Fish and Wildlife Service's (USFWS's) Anadromous Fish Restoration Program (AFRP) (USFWS 2015), between 1967 and 2010, the in-river catch of Chinook salmon in the Central Valley by sport anglers averaged 57,611 fish. Average annual in-river catch has been higher over the past two decades than in the preceding 25 years, with catches from 1992–2010 averaging about 64,900 salmon, compared to an average of 51,200 from 1967–1991.

In addition to commercial and sport fishing, California has approximately 100 recognized tribes, some of which engage in traditional uses of fish (Shilling et al. 2014). Currently, CDFW uses the term "recreational" for fishermen who do not earn revenue from their catch, but fish for pleasure or for personal consumption. Information on subsistence fishing by tribal members in California is captured within the broader scope of sport fishing data (Norman et al. 2007; Shilling et al. 2014).

Contribution of Central Valley Salmon to Ocean and Inland Fisheries

Located within California's Central Valley, the Sacramento-San Joaquin River system is the principal producer of Chinook salmon caught in California's ocean fisheries. Its salmon runs also contribute to the ocean fisheries of Oregon and Washington (CDFW 2014). Historically, the rivers in the SJR Watershed supported abundant populations of spring- and fall-run Chinook salmon and steelhead (discussed in greater detail in Chapter 7, *Aquatic Biological Resources*). However, degradation of habitat and increasing pressures from the human expansion has negatively affected those populations. Today, only a relatively small population of fall-run Chinook salmon remain in the three eastside tributaries to the LSJR. These fish pass through the LSJR during their migrations to and from the Delta and Pacific Ocean, where they contribute to the commercial and sport ocean salmon fisheries.

According to historical data maintained by the AFRP, 1967–2010, the average annual ocean catch of Central Valley Chinook salmon by San Francisco and Monterey port area-based boats was 382,070 fish per year. Of this total, 71 percent of the landings were by commercial fishermen and 29 percent were by sport anglers. Furthermore, based on the historical data, it was estimated that 95 percent of the catch originated from the Sacramento River Watershed, with the remaining 5 percent originating from the SJR Watershed. Based on these estimates, the average annual commercial and sport ocean catch of Chinook salmon originating from the SJR totaled about 13,560 and 5,540 fish, respectively, between 1967 and 2010. Catch data for boats based in the Fort Bragg, Eureka, and Crescent City port areas were not available; however, data from recent years suggest that a large proportion of the commercial and sport salmon harvest in these areas originates from Central Valley watersheds (CDFW 2012, 2013, 2015).

Recent Salmon Fishery Closures in California

As discussed above, in 2008 and 2009 the sudden decline of the Sacramento River Basin fall-run Chinook salmon population led the PFMC to almost completely close salmon fishing seasons for the first time in California's history. In both years, the ocean commercial salmon fishery was completely closed. The ocean recreational salmon fishery also was closed in 2008, but was opened for a 10-day period in 2009 (August 29–September 7) from Horse Mountain (near Shelter Cove) to the Oregon border, allowing fishing along the northernmost portion of the California coast (PFMC 2010). Fishing rebounded beginning in 2010, but still remains below the levels prior to the closures (NMFS 2014.)

Recreational fishing for salmon in Central Valley rivers was also highly restricted in 2008 and 2009 relative to recent years. In 2008, an estimated 650 Sacramento River fall-run Chinook salmon were harvested during a 2-month season lasting from November 1 through December 31, which was only 1 percent of the river run. Angler surveys conducted in the Sacramento River Basin for 9 years between 1991 and 2007, during which harvest regulations were much less restrictive than in 2008, suggested a mean harvest rate of 14 percent of the river run (PFMC 2009). In 2009, the Upper Sacramento River late fall-run fishery was the only Central Valley fishery open to Chinook retention, and in an attempt to decrease harvest and protect Sacramento River fall-run Chinook, the fishery was not opened until November 16, 2009. Preliminary estimates indicated that no Sacramento River fall-run Chinook salmon were harvested by recreational anglers in the 2009 late-fall fishery (PFMC 2010).

The prohibition of commercial and recreational salmon fishing in 2008 and 2009 caused substantial economic effects on California's fishing industry, including direct employment and income losses in the fishing industry and secondary employment and income losses in dependent industries. Additionally, the populations of Columbia River Chinook and coho salmon from Oregon and Washington also declined to near record-low levels. In April of 2008, the Governors of all three states (California, Oregon, and Washington) wrote the Speaker of the House requesting assistance in obtaining emergency appropriations to help mitigate the economic impact, which at the time totaled $290 million and included the loss of more than 4,200 jobs (Schwarzenegger et al. 2008).

Two subsequent studies estimated similar impacts on industrial output and employment in California caused by the closures of the ocean salmon fisheries. The first study as reported in

CDFW's *Outdoor California*[10] magazine (Morse and Manji 2009), estimated that the 2008 closure cost the California economy $255 million in industrial output and 2,263 jobs. The publication also estimated that the 2009 closure resulted in a loss of $279 million in output and 2,690 jobs. The closures put some boat owners and commercial salmon fishermen out of business, causing economic hardships for tackle shops, bait and boat dealers, motels and restaurant owners, and other related businesses during those years (Morse and Manji 2009).

This assessment was corroborated to some extent by a second study of the fishery closure effects conducted by the University of the Pacific Business Forecasting Center (Michael 2010).[11] This study assessed effects relative to 2004 and 2005 salmon fishery production, when annual commercial harvests in California averaged 421,500 salmon. For commercial salmon fishing, the Michael study estimated economic effects for only those directly and indirectly related to salmon harvesting and processing, assuming that no effects would occur at the wholesale, distribution, or retail levels because consumers could switch to substitute products. The Michael study estimated that the fishery closure cost $21.3 million in revenue for the commercial salmon fishing industry, $47.9 million in total income, and 961 total jobs. For recreational salmon fishing, estimated impacts included the loss of $70.5 million in total income and 862 jobs.[12] Combined, the closures of California's commercial and recreational salmon fisheries cost the economy $118.4 million in annual income and 1,823 jobs compared to the income and employment for 2004 and 2005.

The Michael study noted that salmon abundance was much higher in recent decades and that recovery to these levels would generate even larger economic impacts. Additionally, it noted the role of seasonality and dispersion in interpreting the results of its study. For example, the study's employment impacts represent annual averages, whereas an industry with highly seasonal employment patterns such as fishing would have employment impacts at some point during the year higher than those represented by the annual average employment losses. On the other hand, economic effects of salmon fishing are dispersed across hundreds of miles of coastline and inland waterways, somewhat diluting the concentration of effects. However, relatively small fishing communities may feel the effects more acutely than would a larger port area such as San Francisco. These smaller, more-isolated communities, considered somewhat dependent on commercial and recreational fishing, include Crescent City in Del Norte County; Eureka, Trinidad, and Fields Landing in Humboldt County; Fort Bragg, Albion, and Point Arena in Mendocino County; Bodega Bay in Sonoma County; Point Reyes, Marshall, and Bolinas in Marin County; Princeton and Half Moon Bay in San Mateo County; and Moss Landing in Monterey County (Langdon-Pollock 2004; Norman et al. 2007).

The studies above (i.e. Morse and Manji 2009; Michael 2010) did not estimate the potential economic effects caused by curtailment of inland sport fishing for Central Valley Chinook salmon. Although sport anglers can shift their effort to other species when salmon are not available, the

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[10] *Outdoor California* is an official California fish, wildlife, and habitat magazine published by CDFW that describes noteworthy stories on California's native species and habitat.

[11] A third salmon closure study, conducted by Southwick Associates, produced much higher estimates of economic impacts than did CDFW and Michael studies. However, Michael (2010) concluded that several methodological flaws led to highly exaggerated estimates of commercial fishing-related impacts, particularly for effects in California's retail and salmon distribution sectors.

[12] Note that the modeling of recreational salmon fishing effects used only the expenditures of out-of-state anglers based on the premise that recreational spending by in-state anglers may simply be transferred to fishing effort for different species or entirely out of fishing and directed towards other recreational pursuits in the area, offsetting the effects attributable to decreased salmon fishing.

reduction of salmon fishing opportunities in Central Valley rivers likely adds to the economic effects estimated by the two ocean closure studies.

In 2006, a federal socioeconomic study conducted by PFMC and the National Marine Fisheries Service (NMFS) evaluated the needs of fishing communities. The study identified several Northern California counties and port communities as “most vulnerable” and “vulnerable” with high levels of dependence on commercial fishing and low levels of resilience. For example, the county of Del Norte was classified as "vulnerable," and the counties of Humboldt, and Mendocino were classified as “most vulnerable.” Additionally, the communities of Crescent City, Eureka, Fort Bragg, Point Arena, and Bodega Bay were classified as “vulnerable." These areas may be particularly susceptible to fishery closures and the associated economic losses that occur.

Effects on Commercial and Sport Fisheries

Expected Effects on Salmon in the San Joaquin River Watershed

The impacts of LSJR Alternatives 2, 3, and 4 on aquatic resources are detailed in Chapter 7, *Aquatic Biological Resources*, and summarized in Table 7-1. Reservoirs releases on the LSJR tributaries are made in response to multiple operational objectives, including flood management, downstream diversions, instream flow requirements for fisheries, instream water quality requirements, and water quality and flow objectives at Vernalis. Under LSJR Alternatives 2, 3, and 4, increased flows would largely be confined within existing channels, preventing an increase in flood frequency, and would have similar timing and magnitude compared to historical flows. As a result, increased flows from LSJR Alternatives 2, 3, and 4, with and without adaptive implementation, are not anticipated to have substantial adverse impacts on fish species in the tributary watersheds and LSJR. Specifically, flow alterations would not be sufficient to substantially impact aquatic resources in the tributary rivers or watershed reservoirs. As a result, impacts on fish species in the tributary rivers and reservoirs, and consequently on recreational fisheries, would be less than significant.

The potential benefits of the LSJR alternatives on aquatic resources are detailed in Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow Between February 1 and June 30*, and Chapter 3 of Appendix C, *Technical Report on the Scientific Basis of Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*. The following information is largely taken from those sources and repeated here for ease of reference.

The results shown in Chapter 19 indicate that there would be significant temperature benefits for Central Valley fall-run Chinook salmon and Central Valley steelhead on the eastside tributaries and the mainstem LSJR under some of the alternatives. These fish evolved to spawn and develop at higher elevations where the water temperatures are colder. However, with the construction of the rim dams they can no longer reach these elevations and must spawn in the lower, warmer reaches of the tributaries. Increasing flow in tributaries at the right times can help buffer streamflow temperatures against hotter air temperatures in the late spring and early summer, when young salmon are developing and migrating. Significant temperature improvements are expected on the Stanislaus and Merced Rivers, primarily under LSJR Alternatives 3 and 4, with and without adaptive implementation (i.e., requirements of 40–60 percent unimpaired flow). On the Tuolumne River, significant temperature improvements are expected under all LSJR alternatives, with the least benefit under LSJR Alternative 2, and the most benefit under LSJR Alternative 4, both without adaptive implementation.

In addition to temperature benefits, results indicate that providing more flow of a more natural regime during the February–June time period would significantly increase the amount of floodplain habitat that is available to native fish. Increasing the floodplain area or duration could provide several benefits for young salmon, including cover from predators, greater access to food resources, and low flow zones to rest in. Higher unimpaired flow requirements will produce greater benefit, in terms of floodplain frequency and magnitude (and presumably duration), compared to lower unimpaired flow requirements or baseline conditions. In general, flood inundation will increase the most (compared to baseline) during the months of April, May, and June under the LSJR alternatives.

Potential Effects on Use and Non-Use Values Resulting from Improved Salmon Production

The following assessment focuses on potential use and non-use benefits associated with supporting and maintaining sustainable Chinook salmon populations in the Stanislaus, Tuolumne, and Merced Rivers. The assessment of use benefits focuses on potential commercial and recreational[13] fishing-related economic effects. Information collected by CDFW, PFMC, USFWS, AFRP, and others is used to characterize the economic values of existing commercial and sport fisheries that could be affected by LSJR Alternatives 2, 3, and 4.

Potential non-use benefits (i.e., monetary values associated with just protecting fish resources rather than from directly using fish resources) also are considered in this section. Although this assessment is necessarily more qualitative because of the lack of specific information on potential effects on salmon populations and other native species, estimates of non-use monetary values, as measured in terms of the public's willingness to pay (WTP) for programs or actions designed to restore or enhance fish populations, are presented for context. For this assessment, non-use values (passive use values) are defined as the non-fishing public's perceived values associated were merely knowing that salmon are being protected, even if these individuals have no intention to ever use the resources.

Improving salmon production in the Stanislaus, Tuolumne, and Merced Rivers would improve Central Valley adult escapement rates for salmon and could help avoid salmon fishery closures in the future. Healthier populations and more viable fisheries could have economic benefits for California residents and businesses, as well as for out-of-state visitors or those who reside out of the state but place value on maintaining and improving Central Valley fish species. As discussed above under *Recent Salmon Fishery Closures in California*, the closures of the ocean commercial and sport fisheries in 2008 and 2009 cost the California economy an estimated $255–$275 million in industrial output (sales), $118 million in personal income, and 1,800–2,700 jobs during each year of the closure. If economic effects from curtailment of the freshwater sport salmon fishery also are considered, the total economic impact would be substantially greater. There is also a direct relationship between the prosperity of fishing-dependent communities in the Central Valley and along the Pacific Coast and the viability of commercial and recreational fisheries that contribute economic activity to these communities. Additionally, there is a direct benefit for residents of California and other regions to avoid further extinctions of California's salmon and other native fishes.

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[13] Recreational and sport fishing refer to the same activity; the term *sport fisheries* is used in this section to refer to marine and freshwater areas where sport fishing activities are managed. This terminology is intended to differentiate fishing activity from more general recreational activities discussed in Section 20.3.6, *Effects on Recreational Opportunities, Activity, and the Regional Economy.*

Non-use values are considered public goods that can be simultaneously enjoyed by millions of people across a region and the country (Loomis 1996). Existence value is a non-use value defined as the benefit received from simply knowing that a resource exists even if no use is made of it. Increasing stocks of Chinook salmon and steelhead in the SJR Watershed to sustainable levels would have associated existence values as it provides assurance that the resource will continue to exist. Although data on salmon recovery rates and associated population levels is too limited to reliably estimate non-use values associated with recovering Chinook salmon in the SJR Watershed, these values are conceptually measurable and would likely differ to some extent among LSJR Alternatives 2, 3, and 4.

Table 20.3.5-3 identifies four salmon restoration programs with studies conducted to estimate non-use values associated with the restoration programs. Typically, non-use values can only be measured reliably by designing and implementing program-specific public surveys; however, the number of such studies is very limited due to the time and costs associated with conducting public surveys of this nature. Although the underlying reason for conducting the four studies referenced in Table 20.3.5-3 was similar (i.e., to estimate the monetary value that the public would place on restoring salmon habitat and populations), each study embodied different actions for achieving the salmon restoration goals of the programs. In the case of the Elwha River and the Klamath River, removing dams that blocked access to habitat important for salmon was central to the program. In the case of the Columbia River, interest in substantially increasing (doubling) salmon runs was the overriding goal. Lastly, the Upper SJR study was part of a broader federal and state program to improve deteriorating habitat conditions for fish and wildlife resources in the San Joaquin Valley.

Acknowledging non-use values similar to those in Table 20.3.5-3 is important to a comprehensive assessment of costs and benefits for LSJR Alternatives 2, 3, and 4. Although difficult to accurately measure without conducting a public survey tailored to the outcomes of specific physical and biological program objectives, the importance of relevant non-use values in an economic assessment of the plan amendments should not be overlooked. Oftentimes, estimates of non-use values can total in the hundreds of millions of dollars or more. However, thoroughly understanding important causal relationships between restoration (e.g., enhanced flows) and the resulting physical and biological outcomes is challenging. As such, the best result that typically can be expected from a review of values similar to those studies identified in Table 20.3.5-3 is to develop a contextual foundation for these values. This foundation provides an understanding about the general magnitude of non-use values and their contribution to the economic calculus.

The evaluation described above is limited to potential use and non-use benefits associated with supporting and maintaining sustainable populations of Chinook salmon in the three eastside tributaries. As noted, improving salmon production in the Stanislaus, Tuolumne, and Merced Rivers would be expected to improve Central Valley adult escapement rates and could help avoid salmon fishery closures in the future, resulting in direct economic benefits to California businesses and residents. There also may be additional benefits to other native fish species and other plant and animal species at spatial scales that extend beyond the scope of the plan amendments; however, uncertainty and lack of information on the potential biological effects preclude a more quantitative evaluation of these benefits.

Table 20.3.5-3. Existing Studies that Estimate the Non-Use Monetary Benefits Associated with Restoring Salmon Populations, as Measured by the Public's Willingness to Pay

	Upper San Joaquin River Study (1990)[a]	Columbia River Study (1989)[b]	Elwha River Study (1996)[c]	Klamath River Study (2012)[d]
Description of Salmon Program Benefits	Increase annual populations of Chinook salmon in the Upper SJR from less than 100 fish to about 15,000 fish as a result of increasing flows in the river	Restore (double) annual salmon and steelhead runs (increase of 2.5 million fish annually) as a result of habitat restoration efforts	Increase pink salmon runs by 200,000 fish annually and chum, steelhead, and Chinook runs by 100,000 fish annually as a result of dam removal/habitat restoration	Increase populations of wild salmonids (Chinook salmon and steelhead), with increases ranging from 30% to 150%; changes in extinction rates for the shortnose and Lost River suckers, and for coho salmon as a result of dam removal/habitat restoration
Estimates of Annual Willingness to Pay (WTP) per Household	Annual WTP benefits ranged from $103 per household (out-of-state residents) to $202 per household (residents of the San Joaquin Valley) (in 1990 dollars)	Monthly WTP benefits range from $2.21 per respondent to $4.88 per respondent (in 1989 dollars), depending on the probability of future use of the river for salmon fishing	Annual WTP benefits vary by location of respondent, ranging from $59 per household for residents of Clallam County, to $73 per household for residents elsewhere in Washington State; out of state residents indicated an average (mean) WTP benefit of $68 annually (in 1996 dollars)	WTP benefits vary by program characteristics; annualized values (discounted) range from $65.82 to $112.28 per household (in 2012 dollars)

Sources:

[a] Jones & Stokes Associates, Inc. 1990.

[b] Olsen et al. 1991.

[c] Loomis 1996.

[d] RTI International 2012.

Effects of Commercial and Sport Fisheries on Regional Economies

This section addresses potential effects on fishery-dependent regional economies from flow-related effects on recreational and commercial fisheries. The analysis considers potential changes in fisheries associated with improved conditions for native fisheries affected by LSJR Alternatives 2, 3, and 4.

Potential effects on regional economic conditions caused by changes in fishery conditions in the three tributaries and the LSJR can be viewed by tracing the underlying relationship between fishing activity (both commercial and sport fishing activity) and regional economies affected by this activity. Conceptually, local and regional economic activity generated by the use of fishery resources can be followed from the availability of (and changes to) the resources to the generation of employment and income within a region. Management of commercial and sport fishery resources in marine waters, as well as those at freshwater reservoirs and rivers, affects the amount and type of commercial and sport fishing activity at different fishing areas. Changes in the availability and management of fishing facilities result in changes in sport fishing activity, which, in turn, typically alters the location and level of fishing-related spending. For example, a highly developed facility, such as a marina with a resort and restaurants, boat slips, and boat launching facilities, may attract large numbers of anglers from outside the region who spend money on accommodations, restaurant meals, boat rentals, and fuel in the vicinity of the facility. Alternatively, an undeveloped campground on a reservoir may attract relatively few anglers from outside the local area, resulting in fishing-related spending that largely consists of food and gasoline purchases made at home or en route to the site.

As discussed previously in this section, fisheries-related activities in the study area would likely increase under LSJR Alternatives 2, 3, and 4 in response to enhanced populations of salmon and other native fish species. LSJR Alternative 2 would likely have a relatively minor impact on fisheries-related economic activity, but the economic benefits would grow under Alternatives 3 and 4 as salmon populations further increase. However, the overall economic and employment effects for most businesses directly and indirectly linked to fishing activity in the study area would likely not be substantial. Some small, fishing-dependent communities, where fishing-related activity contributes more than just minimally to local economic activity, may see greater economic benefits.

As discussed in Section 20.3.5, *Effects on Fisheries and Associated Regional Economies*, implementation of the San Joaquin River Restoration Program[14] (SJRRP) is expected to have fishery-related benefits, which, in turn, would benefit fishery-dependent communities within the study area. When considered in conjunction with the SJRRP, the plan amendments may have a more substantial effect on economic activity for fishery-dependent communities in the study area. In addition, greater economic activity could also bring additional economic opportunities (i.e., jobs, income) to these areas.

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation

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[14] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are expected to increase the existing SJR flows at Stevinson in the near future

methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood of changing economic effects as it would allow the unimpaired flow requirements to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow). For LSJR Alternative 2, an increase from 20 percent to 30 percent of the unimpaired flow would likely result in different effects as compared to those shown above for LSJR Alternative 2, depending upon flow conditions and frequency of the adjustment. As such, under LSJR Alternatives 2 or 3, if the percentage of unimpaired flow is increased with adaptive implementation method 1, regional economic effects related to enhanced fisheries could increase more than conditions without adaptive implementation. Under LSJR Alternatives 3 and 4, if the percent of unimpaired flow could be reduced with adaptive implementation method 1, if there were no effect on fish, and as such, use and non-use benefits and regional economic conditions would not be expected to change much compared to conditions without adaptive implementation.

20.3.6 Effects on Recreational Opportunities, Activity, and the Regional Economy

Introduction

As described in Chapter 10, *Recreational Resources and Aesthetics*, changing flow regimes and reservoir-storage levels may potentially affect the timing, duration, and quality of recreational opportunities. Therefore, implementation of LSJR Alternatives 2, 3, and 4 may affect recreational activities through adoption of new and updated water management practices that could alter reservoir-storage levels and downstream releases.

Changes in reservoir-storage levels could affect recreational activities primarily by reducing access to boat ramps, marinas, and boat-in campgrounds; reducing water surface area for boaters; and exposing large areas of shoreline, negatively affecting aesthetic quality and access for picnickers, swimmers, and shore side users. Changes in downstream flows could affect both water-dependent and water-enhanced recreation in the Stanislaus, Tuolumne, and Merced Rivers and potentially along the LSJR. Furthermore, altering the timing, duration, and quality of recreational opportunities could affect the value that recreationists place on the activities and, in turn, change the frequency with which these recreational resources are used.

As described in Gallo (2002), recreational opportunities can generate economic benefits through two pathways. The first pathway is the value (net benefit) to those participating in the activities, as indicated by their willingness to pay over and above trip expenditures (i.e., transportation and parking fee costs) for these recreational opportunities. This measure of value depends, to a large extent, on the quality of the recreation environment. For example, wildlife watching is more rewarding when there is more viewable wildlife, creating greater value in that environment. Improving the quality of the environment can augment recreational benefits, which is typically measured by the increase in willingness to pay (i.e., monetary value over and above trip-related expenditures) for the recreational activities.

The second pathway to assess the economic contribution of recreational opportunities is the beneficial impacts that recreation-related spending by nonresidents of a region brings to a local economy where the nonresidents are visiting. Nonresidents are particularly important in this regard because their economic activities may not otherwise occur within the region. More frequent trips by visitors means additional spending in the region. These types of economic effects are typically referred to as *regional economic impacts*, where a region can range from a small geographic area (e.g., a county or city) to a large multi-county area. While these effects do not directly affect residents, increased visitor spending does support local economic activity. Although not considered here, those who do not directly use the improved environment for recreational activities may still benefit just from knowing that biodiversity is enhanced and from other environmental enhancements that contribute to amenity values (i.e., non-use value).

The study area for evaluating recreation-related economic effects in this analysis includes the reservoirs (i.e., New Melones, New Don Pedro, and Lake McClure) and the three eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers) extending from the reservoirs, downstream, to the LSJR. (Potential economic effects of LSJR Alternatives 2, 3, and 4 on fishing are discussed in Section 20.3.5, *Effects on Fisheries and Associated Regional Economies.*) This section begins by presenting a description of baseline conditions, including information on recreational activity in the study area and its relationship to river flows and reservoir levels. Then, potential effects of the LSJR alternatives on recreational opportunities, participant benefits and recreation-related spending are assessed. This assessment is followed by a qualitative assessment of potential recreation-related regional economic impacts on the regional economy.

Description of Baseline Conditions

In this analysis, estimates of existing recreational use help establish a baseline of potentially affected recreational activity and associated spending in the study area. Table 20.3.6-1 presents estimates of baseline recreational use, in terms of annual visitor days, at recreation areas in the study area. Approximating recreation activity at the specific locations identified in Table 20.3.6-1 is useful for evaluating the relative economic importance of these recreational areas within the surrounding region. Although some of the values in Table 20.3.6-1 are somewhat dated, these estimates are considered to reasonably characterize existing recreational activity because of the many factors affecting recreational use levels over time, both positively and negatively.

As shown in Table 20.3.6-1, annual recreational use at New Melones Reservoir, Don Pedro Reservoir, and Lake McClure totals about 2.4 million visitor days, of which it is assumed that residents and non-residents each account for about 50 percent of the total. Annual recreational activity along the Stanislaus, Tuolumne, and Merced Rivers and the LSJR totals an estimated 710,200 visitor days. Although the proportion of visitor days to the eastside tributaries made by residents or nonresidents is unknown, it is assumed to be similar to the proportions at the reservoirs (50 percent made by residents and 50 percent made by non-residents of the study area).

For this analysis, recreational activities are grouped according to flow ranges developed by Whittaker and Shelby (2003) to support different types of river recreation activities. Based on this study, low-range flow activities, like swimming, account for about 25 percent of all use; that mid-range flow activities, including motorized boating, rafting, and kayaking, account for about 60 percent of all activities; and that high-range flow activities, such as advanced kayaking and rafting, account for about 15 percent of all activities.

Table 20.3.6-1. Estimated Use (in Visitor Days) of Affected Recreation Areas, by Watershed

Watershed/Recreation Area	Counties	Estimated Visitor Days (Year)	Type of Activities
Stanislaus	San Joaquin, Calaveras, Tuolumne, Stanislaus		
New Melones Reservoir		800,000 (2011)[a]	All activities
Stanislaus River		330,200 (1999)[b]	Fishing, camping, swimming, whitewater boating, water-enhanced activities
		5,200 (average of 1999/2000)[c]	Fishing only
Tuolumne	Tuolumne, Stanislaus		
Don Pedro Reservoir		244,000 (peak season, April through September - 2012)[d]	All activities
Tuolumne River		150,000 (1992)[e]	Boating, fishing, swimming, rafting, wildlife viewing
		34,900 (2000)[f]	Fishing only
Merced	Mariposa, Merced		
Lake McClure		1,400,000 [2010][g]	All activities (camping, boating, swimming, hiking, bicycling, house boating, fishing)
Merced River		73,000 [1999][h]	Kayaking, rafting, canoeing, water-enhanced activities
Lower San Joaquin River	San Joaquin, Stanislaus, Merced	157,000 [2001][i]	Boating and fishing
		57,500 [2000][j]	Fishing only

Sources:

[a] USBR 2011; use is measured in 12-hour recreation visitor days (RVDs).

[b] MacAfee 2000.

[c] Derived based on information from CDFG 2001a and 2001b; includes reach of the river from Goodwin Dam (Tulloch Reservoir) downstream to the McHenry Avenue bridge near Meyers.

[d] TID & MID 2013.

[e] USBR 1999; use is measured in 6-hour RVDs.

[f] Derived based on information from Gallo 2002. Note that estimates in Table 20 of the Gallo report were adjusted to account for all visitors; as stated in the referenced report, county residents account for an estimated 51 percent of all recreation days.

[g] As cited in Merced ID 2014.

[h] As cited in USBR 1999; use is measured in 6-hour RVDs.

[i] As cited in USBR 2001; use is measured in 6-hour RVDs.

[j] Derived based on information from Gallo 2002. Note that estimates in Table 20 of the Gallo report were adjusted to account for all visitors; as stated in the referenced report, county residents account for an estimated 51 percent of all recreation days.

Residents of the study area who use the rivers and reservoirs for recreational activity are estimated to receive, on average, $25 (in 2007 dollars) per visitor day in net benefits, as measured by their willingness to pay for these recreational opportunities over and above their trip-related expenditures (Hanemann 2005). Non-residents of the region who use the rivers and reservoirs for recreational activity are estimated to spend, on average, $30 (in 2007 dollars) per visitor day (Hanemann 2005). Based on information presented in Table 20.3.6-1, the three eastside tributaries and their upstream rim reservoirs account for about 3.5 million visitor days per year. Assuming that half of the visitors to the region are residents of the region and the other half are non-residents, the residents spend an estimated $43.7 million per year and the non-residents spend about $52.5 million per year, which have additional benefits for residents in terms of generating local economic activity.

Effects of the LSJR Alternatives

This section describes the potential effects on recreational activity and associated economic effects from changes in recreational opportunities in the study area under the LSJR Alternatives 2, 3, and 4. The assessment is based primarily on predicted flow differences between modeled baseline conditions and the LSJR alternatives, as presented in Chapter 10, *Recreational Resources and Aesthetics* (Tables 10-4 through 10-6), and on how changes to reservoir storage levels could impact recreational opportunities and the use of recreational facilities at affected reservoirs (Tables 10-8 through 10-13).

Effects on River Recreational Activities

This analysis uses hydrology modeling results for the LSJR alternatives to measure the frequency of flows within particular ranges that support different types of river recreational activities, as presented in Chapter 10, *Recreational Resources and Aesthetics*, (see Tables 10-4 through 10-6). Although optimal flows vary for each river due to hydrologic and geomorphic conditions, flows can generally be classified into the following flow ranges for purposes of evaluating potential effects on certain types of recreational activities.

- Low-range flows (less than 500 cfs) for supporting swimming, floating, canoeing and kayaking.
- Moderate-range flows (between 500 and 1,500 cfs) for supporting motorized boating, rafting, and kayaking (but may still support swimming, wading, and floating, particularly in certain locations).
- High-range flows (between 1,500 and 2,500 cfs) for supporting advanced rafting or kayaking.

A flow above 2,500 cfs is generally considered unsafe for recreational activities, although advanced whitewater rafting and kayaking often still take place.

Although impacts on recreational opportunities and activities, and associated economic effects, would be relatively minor under all LSJR alternatives, these effects would vary by alternative and river.

Under LSJR Alternative 2, the frequency of low-range, moderate-range, and high-range flows on the Stanislaus, Tuolumne, and Merced Rivers would not substantially change. The Merced and Tuolumne Rivers would experience a slight decrease in the frequency of low-range flows when compared with modeled baseline conditions (see Tables 10-4 and 10-5); however, a slight increase in the frequency of moderate flows could offset the impact of changes in the frequency of low-range flows on recreation activity on these rivers. The Stanislaus River would experience even less change in the frequency of low-range, moderate-range, and high-range flows (see Table 10-6). Overall, changes in flows under LSJR Alternative 2 would not be expected to substantially impact recreational activities on these rivers.

Under LSJR Alternative 3, the frequency of low-range flows on the Merced River would likely decrease, while the frequency of moderate-range and high-range flows would be expected to increase. Overall, recreational opportunities could be slightly greater, primarily because activities associated with the more frequent moderate-range (500–1500 cfs) and high-range (1,500–2,500 cfs) flows could more than offset the expected decrease in recreation activity supported by low-range (<500 cfs) flows (see Table 10-4). Conversely, the frequency of low-range and moderate-range flows on the Tuolumne River would likely decrease, whereas the frequency of high-range flows would be expected to increase. There would also be an increased frequency of flows over 2500 cfs that do not support most recreational activities. Overall, recreational opportunities on the Tuolumne River could slightly decrease as recreation activity supported by low-range and mid-range flows could more than offset the increased activity supported by high-range flows (see Table 10-5). Finally, on the Stanislaus River there would be minor shifts in the frequency of low-range, moderate-range, and high-range flows and, therefore, recreation activity would be more or less unchanged under LSJR Alternative 3 (see Table 10-6).

Under LSJR Alternative 4, flow frequency impacts would be similar to those under LSJR Alternative 3. On the Merced River, the frequency of low-range flows would likely decrease while the frequency of moderate-range and high-range flows would increase, resulting in slightly greater recreational opportunities and activity (see Table 10-4). On the Tuolumne River, the frequency of low-range and moderate-range flows would likely decrease slightly, while the frequency of flows over 2500 cfs would increase. In response, recreational opportunities and activities could slightly decrease on the Tuolumne River because activities that rely on low-range and moderate-range flows could not be performed as often (see Table 10-5). Finally, on the Stanislaus River the frequency of low-range and moderate-range flows would slightly decrease, whereas the frequency of flows over 2500 cfs would increase. As a result, recreational opportunities on the Stanislaus River may slightly decrease, as activities that rely on low-range and moderate-range flows could not be performed as often (see Table 10-6).

In summary, flow changes associated with LSJR Alternatives 2, 3, and 4 would be expected to result in minor increases or decreases in recreational opportunities and activities in the three eastside tributaries. Low-range flows would likely occur less frequently under the LSJR alternatives, while high-range flows would likely occur more frequently. In turn, there may be slight shifts in the types of recreational activities performed, depending on historical use of each river. As flows shift higher more people may participate in boating rather than wading, but overall recreational opportunities should remain more or less unchanged. Consequently, benefits to local residents and potential effects on visitor spending in the region associated with recreational activity on the tributaries would be relatively unchanged under LSJR Alternatives 2, 3, and 4.

Effects on Reservoir Recreational Activities

As discussed in Chapter 10, *Recreation Resources and Aesthetics*, operational changes at the three rim reservoirs (New Melones Reservoir, Don Pedro Reservoir, and Lake McClure) under LSJR Alternatives 2, 3, and 4 would be expected to have less than significant (and presumably slight) effects on recreational opportunities and associated activity. Overall, recreational opportunities and use at all three reservoirs would be expected to decrease slightly or remain generally unchanged under LSJR Alternatives 2, 3, and 4 (see Tables 10-8 through 10-13). Under LSJR Alternative 2, the relatively small changes in reservoir elevations would not be expected to affect levels of recreational activity at any of the reservoirs. Under LSJR Alternative 3, the predicted changes in reservoir elevations would not be expected to substantially affect recreational use levels at any of the three rim reservoirs; however, elevation shifts at New Don Pedro Reservoir would be more noticeable than at the other two reservoirs, although recreation opportunities and associated activities still would not be expected to decrease substantially (see Tables 10-10 and 10-11). Finally, under LSJR Alternative 4, predicted changes in reservoir elevations would still not be expected to substantially affect recreational use levels at any of the three rim reservoirs.

Because water levels in all three reservoirs would not change significantly under the LSJR alternatives, the impacts on recreational opportunities at the reservoirs would likely be small. Consequently, benefits to local residents and effects on visitor spending in the region associated with reservoir recreation activity would be relatively unchanged under LSJR Alternatives 2, 3, and 4.

Potential Effects on the Regional Economy

Management of recreational resources in the plan area, including reservoir-elevation levels and river flows, affects recreational opportunities and the number of visitors and types of activities that they take part in. For example, a highly developed recreation area, such as a reservoir that includes a resort with restaurants, boat slips, and boat launching facilities, may attract a large number of visitors from outside the region who spend money in the vicinity of the recreation area. Alternatively, an undeveloped campground may attract relatively few visitors from outside the local area, while local visitors will primarily purchase food and gasoline at home or en route to the site. Conceptually, local and regional economic activity generated by recreational spending can be traced from the use of recreational resources to the generation of employment and income by recreational activities within the region.

Although not quantified for this analysis, potential regional economic effects associated with changes in recreational activity on the three tributaries and rim reservoirs are expected to be minor. LSJR Alternatives 2, 3, and 4 would likely have only minor effects on recreational activity and spending at the eastside tributaries and their associated rim reservoirs. The greatest potential effects would be associated with recreational activity on the Tuolumne and Merced Rivers where implementation of the LSJR alternatives could reduce the frequency of low range flows (<500 cfs), which are optimal for relatively calm water activities such as swimming and wading. In turn, LSJR Alternatives 2, 3, and 4 could also have relatively minor impacts on regional economic activity, as the number of non-local visitors may slightly decrease.

As identified in Section 20.3.5, *Effects on Fisheries and Associated Regional Economies,* implementation of the SJRRP is expected to provide additional recreational opportunities in the SJR Watershed that would benefit the local and regional economy. It has been estimated that the additional recreational activity (including fishing) provided by the SJRRP could support 475 recreation industry jobs annually by 2025 (Kantor 2012). The stimulus of economic activity from the SJRRP would result in a cumulative economic benefit to the local and regional economy within the SJR Watershed.

Adaptive Implementation

Adaptive implementation would take place based on required evaluation of current scientific information and would need to be approved as described in Appendix K, *Revised Water Quality Control Plan.* Accordingly, the frequency and duration for any use of adaptive implementation methods 1, 2, 3, and 4 cannot be determined at this time. Adaptive implementation method 1 potentially has the greatest likelihood of changing economic effects as it would allow the unimpaired flow requirements to be increased or decreased by up to 10 percent from the objective unimpaired flow (with a minimum requirement of 20 percent and a maximum of 60 percent unimpaired flow); however, this would likely result in tradeoffs between river and reservoir recreation economic effects. Methods 2 and 3 could change the timing of the flows and if more water is held in the reservoirs for later release, this might help reservoir and maybe river recreation. Overall, given the very small changes in recreational opportunities, it is not expected that adaptive implementation would substantially change the effects presented above.

20.3.7 Non-Flow Measures

This section provides cost estimates associated with implementing non-flow measures that affected entities or resource agencies (e.g., CDFW) may undertake between the rim dams on the Stanislaus, Tuolumne, and Merced Rivers and the confluence of the LSJR. These measures would inform the body of scientific information potentially used to make adaptive implementation decisions under LSJR Alternatives 2, 3, and 4. The costs described are based on reference projects and incorporate standard assumptions regarding the type and potential location of non-flow measures. These measures, which are grouped into habitat restoration, fish passage improvements, and other actions, include the following.

Habitat Restoration

- Floodplain and riparian habitat restoration.
- Gravel augmentation.
- Enhanced in-channel complexity.
- Improve temperature conditions.

Fish Passage Improvements

- Fish screens (screen unscreened diversions in tributaries and LSJR).
- Permanent physical barrier in the southern Delta.

Other

- Predatory fish control.
- Invasive species control (i.e., plant control).

The cost information described below is summarized from information presented in Chapter 16, *Evaluation of Other Indirect and Additional Actions*. The availability of information pertaining to the costs associated with several of the non-flow measures identified in Chapter 16 is very limited as such is not presented here. This includes reduction of vegetation disturbing activities and removal of human-made barriers to fish migration. In particular, the costs associated with the removal or modification of human-made barriers to fish migration are not presented below because the feasibility of this non-flow measure is unknown, as discussed in Chapter 16.

Floodplain and Riparian Habitat Restoration

Floodplain and riparian habitat restoration can be achieved through different approaches. While site specific conditions influence the cost of each approach, removal of riprap or other bank protection and active plantings are considered generally lower cost approaches, as compared to creating or expanding natural or engineered floodways, modifying river and floodplain geometry, or hydrologic reconnection of historical floodplains through levee breaches and/or setbacks. Removal of riprap and active plantings typically require fewer feasibility and design studies, fewer permits, and the involvement of fewer responsible agencies, and require limited adaptive management and mitigation monitoring plans to evaluate the effectiveness of the projects. In addition, removal of riprap and active plantings are less likely to require the purchase of property, which can be a substantial cost associated with floodplain and riparian habitat restoration.

Examples of floodplain and habitat restoration projects include the following.

- The Lower San Joaquin River Floodplain Protection and Restoration Project that acquired a total of 223.54 acres of wildlife habitat adjacent to the SJR and eastside tributaries for preservation and future enhancement of riparian and wetland habitats for an estimated cost of $1.1 million.
- The Basso Bridge Ecological Reserve and Merced River Ranch Land Acquisitions on the Merced River were purchased for approximately $830,000 in 1997 to protect spawning riffles and enhance riparian species. At the time, the purchase was simply to secure the land, with no active restoration planned. Depending on the size, scale, and location of a project, levee breaches can be very costly.
- The Cosumnes River floodplain restoration project where the U.S. Army Corps of Engineers breached and abandoned 5.5 miles of levees to allow the river to flow into the floodplain as a result of the 1997 floods. This project cost an estimated $1.55 million.

Gravel Augmentation

The cost of gravel augmentation is substantially influenced by site specific conditions. Generally, gravel injection is a low cost approach, whereas hydraulic structure installation is a higher cost approach. The costs associated with gravel injection primarily relate to fuel costs for gravel delivery. These costs are estimated at $15–$20 per ton, plus $0.16–$0.20 per mile to transport. Gravel injection is typically used where flows are high enough to mobilize the material, such as downstream of a reservoir or at locations with easy access to the river for gravel placement.

Spawning bed enhancement is more expensive than gravel injection as it typically requires engineering design. The cost of spawning bed enhancement, which does not include engineering design, is estimated at $25–$33 per ton ($19–$25 per cubic yard). Choosing an appropriate location and gravel mix is crucial for successful augmentation.

Hydraulic structure installation is generally the most expensive gravel augmentation approaches because it requires engineering analysis and in-stream work with heavy equipment that requires permits from different agencies that can take 6–18 months to obtain. Project costs for this approach can range from $1,500 to $100,000 depending on the complexity of the project, project length and materials.

The costs associated with the gravel augmentation approaches described above do not include maintenance and monitoring costs, which depend on the approach selected. Examples of gravel augmentation projects are shown in Table 20.3.7-1.

Table 20.3.7-1. Central Valley Project Improvement Act[a] Spawning and Rearing Habitat Restoration Projects

Project	Description	Construction/ Implementation[b]	Monitoring + Adaptive Management[c]
Sacramento River Project	Annual placement of 10,000 tons of gravel for spawning and rearing habitat restoration – between Clear Creek & Keswick Dam	$795,000	$120,000
American River Project	Annual placement of 7,000 tons of gravel at Nimbus Basin on the American River	$745,000	$6,000 + $100,000
Stanislaus River Project	Annual placement of 3,000 tons of gravel at the Two Mile Bar or Upper Honolulu Bar along the Stanislaus River	$670,000	$15,000
Program Management & Support (for three projects over 2 fiscal years)		$450,000	

Source: Hannon et al 2013.

[a] The Central Valley Project Improvement Act of 1992 (CVPIA) created a collaboration of agencies, including the Department of the Interior, USBR, and U.S. Fish and Wildlife Service in collaboration with state and local governments, tribes and stakeholders.

[b] Costs provided represent the requested funding for fiscal year 2015–2016. Costs represent the amount being cost-shared between the state and federal agencies involved in implementing the CVPIA.

[c] The adaptive management cost is intended for building a model and assembling information to develop model parameters for identifying restoration actions and monitoring priorities for the American River Project.

Enhanced In-Channel Complexity

The costs for enhancing in-channel complexity through the installation of cover structures, boulder structures and log structures depend primarily on the size of the stream, channel hydrology, complexity of the design, site accessibility, cost of materials, and equipment needed to transport and install the material. One of the primary costs associated with enhancing in-channel complexity is that cost for large woody materials (e.g., logs), which is highly dependent on the type of tree selected. For example, Washington Douglas Fir is $100 per 1,000 board feet (ft), whereas the cost for California Redwood is about $510 for the same amount. The National Resources Conservation Services cost share practice standard estimates that the material cost for large woody material ranges between approximately $1,900 per acre and $924 per acre (Guhin and Hayes 2015). The range in approximate costs (low–high) based on stream size is shown in Table 20.3.7-2.

Table 20.3.7-2. Engineered Log Structures and Large Woody Debris—Cost Estimates

Stream Size (cfs)	Cost[a] ($ Thousands) (Low–High)
Small stream (1–100)	10–40
Medium stream (101–2000)	20–70
Large stream (2000+)	10–80

Source: Thomson and Pinkerton 2008.

cfs = cubic feet per second

[a] Estimates identified above include construction, design, permitting, basic monitoring and routine maintenance (up to 2 years), reestablishing site to prior conditions and project management costs. These estimates assume purchased materials.

As part of the Lower Mokelumne River Joint Settlement Agreement (JSA) between East Bay Municipal Utilities District, the USFWS and CDFW, $25,663 in funding to the University of California, Davis was approved in 2008 to conduct a study along the Lower Mokelumne River to determine the effectiveness of large woody materials in aiding fish habitat. The project consisted of placing 542 large wood pieces along 4.8 miles on the Lower Mokelumne River directly below the Camanche Dam where the flows averaged 350 cfs.

Improve Temperature Conditions

Cost information concerning actions to improve temperature conditions, such as installation or modification of selective withdrawal structures, is limited. One factor that substantially affects the cost is construction. Examples of the costs of temperature improvement projects include the following.

- The Lake Natoma Temperature Curtains Pilot Project estimated the cost to be $1,960,196 for a 3-year study that included the installation of 2 curtains (one 700-ft long with a depth of 15-20 ft, second curtain 600-ft long with a depth of 20–25 ft). The costs associated with this pilot project included: design, permitting and environmental review, project management, temperature monitoring, project installation and removal, and project analysis and reporting.
- A temperature curtain was installed at Whiskeytown Lake in 2011 for a cost of $3 million. The new temperature curtain replaced a curtain from 1993 that had deteriorated and was no longer functional. The temperature curtain is 2,400 ft long and drops into the lake 110-ft and is anticipated to achieve a 2–4 degree drop in water temperature.

Fish Screens (Screen Unscreened Diversions in Tributaries and Lower San Joaquin River)

The costs for fish screens vary considerably depending on the size of the existing intake. Typically, screening smaller or private intakes that primarily serve agricultural uses are less costly as compared to the costs for screening large intake projects that primarily serve municipal and industrial uses. Agricultural diversions (with an average diversion rate of 10 cfs) have an estimated cost of $75,000 per diversion (unit cost of $7,500/cfs). Capital costs for agricultural diversion screens in the western United States can range between $3,000 and $20,000 per cfs, with maintenance and operations costs ranging between $3,000 and $5,000 per year.

The Anadromous Fish Screen Program (AFSP) established under the CVPIA has funded several fish screen projects in California. Recent projects include the following.

- Natomas Mutual Sankey Fish Screen Project (total cost of about $46.0 million) located off the left bank of the Sacramento River replaced existing unscreened diversions with a consolidated 434 cfs fish screen and intake facility.
- RD2035/Woodland Davis Clean Water Agency Joint Intake and Fish Screen (estimated cost of $44 Million) located off the right bank of the Sacramento River replacing unscreened diversion with a consolidated 400 cfs fish screen and intake facility to provide water to irrigate approximately 15,000 acres of crops and serve the cities of Davis, Woodland, and the University of California, Davis campus.

Another large municipal intake in the Central Valley that has been screened is the Davis Ranches Fish Screen Project, located in Colusa County at river mile 132.5. This fish screen consists of installing a self-cleaning, cylindrical, brushed intake fish screen with a retrieving system. The cost for this project is an estimated $414,900, which includes planning, design, project management, construction, installation, and monitoring. Table 20.3.7-3 provides a more detailed breakdown of the costs for the Davis Ranches Fish Screen Project.

Table 20.3.7-3. Design and Construction Costs for Davis Ranches Site 2, Pumps 4 & 5 Project

Cost Category	Davis Ranches Site 2, Pumps 4 & 5[a] ($)
Design & Construction of fish screen	310,964
Eng. Review, Inspection & documentation, permit costs	24,000
Accounting & project management & monitoring	79,940
Total	**414,904**

Source: Griffith 2001.

a Costs represent the total costs over 2 years.

Physical Barrier in the Southern Delta

A permanent operable barrier (gate) at the Head of Old River (HOR) is currently proposed as part of the California WaterFix to prevent out-migrating salmonids from entering Old River in the spring and improve adult passage conditions and water quality (dissolved oxygen) in the SJR (particularly the Stockton Deep Water Ship Channel) in the fall. DWR (2015) produced a report in response to requirements of the NMFS 2009 Biological Opinion on the long-term operations of the CVP and SWP, discussing engineering solutions to reduce diversion of emigrating salmonids. This report discusses the potential engineering solutions for HOR and four other areas in the Delta. The permanent, operable HOR gate is estimated to cost $43,200,000 for construction and $200,000 for operation and maintenance.

Predatory Fish Control

Predatory fish control can be accomplished through direct removal, or by the elimination/modification of habitat conducive to predators. Direct removal of predators is generally less expensive than the elimination/modification of habitat, as described below.

No long-term predator removal programs are in effect in the Delta; however, such programs have been implemented in rivers located in the western U.S. One example is the Upper Colorado Endangered Fish Recovery Program (Recovery Program), which was established in 1988 and is a partnership of local, state, and federal agencies, water and power interests, and environmental groups working to recover endangered fish in the Upper Colorado River. The Recovery Program implements long-term nonnative fish management by removing the most problematic nonnative fish predators from rivers. Among the nonnative fish management projects funded within the Recovery Program are the middle Yampa River northern pike and smallmouth bass removal and evaluation project; and the removal of smallmouth bass in the Upper Colorado River between Price-Stubb Dam near Palisade, Colorado and Westwater, Utah project. The total annual cost of each project from 2010 to 2015 ranged between $157,000 and $214,000.

The costs of habitat modification projects designed to reduce predator habitat in the Delta and upstream tributaries have been estimated as part of several recovery programs including: the Golden Gate Salmon Association Salmon Rebuilding Plan, the NMFS Final Recovery Plan (Recovery Plan), the Tuolumne River Corridor Restoration Plan, and the San Francisco Estuary Project 2007 Comprehensive Conservation and Management Plan. The costs of these projects are influenced by site-specific conditions and depend on the extent of modifications needed. Costs can vary from $100,000–$300,000 per site for reducing predator habitat at large screen structures, to more than $4.6 million for filling a gravel pit to reduce/eliminate habitat favored by predatory bass species, and replacing with high quality chinook salmon habitat. On a broader scale, the costs associated with Recovery Plan implementation projects designed to minimize predation at weirs, diversions, and related structures in the Delta are about $50 million over a period of 50 years.

Invasive Aquatic Vegetation Species Control

The California Department of Boating and Waterways (DBW) implements an Aquatic Weed Control Program, which includes a program to control water hyacinth. Established in 1982, the California state legislature designated DBW as the lead state agency to cooperate with other state, local, and federal agencies in controlling water hyacinth in the Delta, its tributaries, and Suisun Marsh. The total annual cost of DBW's Aquatic Weed Control Program for the years of 2001 through 2007 was between $6.2 and $7.9 million.

20.4 Southern Delta

Consistent with requirements in Water Code Section 13241, this section presents results from evaluating potential costs of compliance with salinity water quality objectives in the southern Delta. Potential effects on ratepayers and the regional economy resulting from higher treatment costs also are considered.

20.4.1 Costs of Methods of Compliance

This section includes a summary of information presented in Chapter 16, *Evaluation of Other Indirect and Additional Actions,* on the costs for WWTPs to comply with salinity objectives in the southern Delta. Because the actual methods of compliance ultimately used are necessarily site- and discharge-specific, only general estimates of compliance costs can be developed for this assessment; as such, this section presents cost ranges. A more precise evaluation of the actual costs is neither required in this plan-level analysis, nor is it feasible without specific information about projects that would be selected by project proponents as they move toward compliance.

As discussed in Chapter 16 and in Chapter 13, *Service Providers,* compliance costs in the southern Delta would be attributable to complying with NPDES based on salinity objectives that could be developed and applied to WWTP dischargers as a result of implementing the southern Delta water quality (SDWQ) alternatives. The Cities of Tracy and Stockton and Mountain House CSD may need to modify wastewater treatment processes or domestic water supply cycles to comply with SDWQ Alternative 2 and those service providers, plus the City of Manteca, may need to modify treatment processes to comply with the No Project Alternative (LSJR Alternative 1 and SDWQ Alternative 1). The following three methods of compliance, which are not intended to be limiting but rather as a sampling of methods available during different stages of the domestic water supply cycle or wastewater treatment cycle, are considered the most likely methods to be implemented by WWTPs to comply with potential NPDES.

- **Developing new source water supplies**. By reducing reliance on highly saline groundwater for potable water demand, salinity discharged to the southern Delta would decrease.
- **Implement salinity pretreatment programs.** Target salinity loading in the sewer collection systems by removing water softeners and reducing salinity discharged to the sewer collection system from commercial, industrial, or institutional dischargers.
- **Desalination at the WWTP.** Remove salts at the WWTP to improve treated water quality and meet waste discharge permit limits.

Additionally, under the program of implementation for SDWQ Alternatives 2 or 3, agricultural dischargers may implement agricultural return flow salinity controls, such as changing the timing of current releases of discharges into the southern Delta. Furthermore, SDWQ Alternatives 2 or 3 could require additional studies of circulation and monitoring of water levels in the southern Delta. Additional studies and monitoring may indicate the continued need for modifying the temporary barriers in the southern Delta. Alternatively, under the program of implementation for SDWQ Alternatives 2 or 3, the State Water Board may determine that installing low-lift pumping stations at the temporary barriers is feasible. These potential costs of these additional methods of compliance are described below.

New Source Water Supplies

Water supplies with high salinity content can contribute to elevated salinity discharges to the southern Delta. Generally, water purveyors in the plan area (e.g., the Cities of Stockton, Tracy, Manteca, and Modesto) rely on a combination of surface water and groundwater to meet potable water demand. Groundwater is typically more saline than surface water in the SJR Basin.

One method to reduce salinity discharges is to use more high quality water (i.e., surface water) to meet water demands. To obtain more surface water, a water purveyor may need to enlarge existing structures (water intake, treatment facility, and pipelines and pumps), or build new structures.

One comparable project is the Davis-Woodland Water Supply Project (DWWSP). The DWWSP will construct a surface water intake, water treatment plant, pump stations, storage tanks, and associated transmission lines to develop 45,000 AF/y of new, high quality water resources on the Sacramento River. The DWWSP is in the construction phase, which began in April 2014, and is estimated to be completed in September 2016. The estimated project costs are detailed in Table 20.4.1-1.

A second comparable project is the Delta Water Supply Project (DWSP), which is being completed by the City of Stockton and will divert water pursuant to Water Code, Section 1485. Water Code, Section 1485 allows any municipality disposing of treated wastewater into the SJR to seek a water right to divert a like amount of water, less losses, from the river downstream of the point of its wastewater discharge. The DWSP will develop 33,600 AF/y of new water resources in the Delta. A new surface water intake, water treatment plant, pump stations, and pipelines have been constructed. The estimated costs for this project are also detailed in Table 20.4.1-1.

Table 20.4.1-1. Design and Construction Costs for the Davis-Woodland Water Supply Project and Delta Water Supply Project

Cost Category	DWWSP (millions)	DWSP (millions)
Design and Construct Intake	$15.6	$22.3
Design and Construct Treatment Facilities and Pipelines	$236.9	$176.6
Project Administration[a]	$33.1	$14.2
Other Local Costs[b]	$51.4	$21.6
Total	$337	$234.7

Source: Price pers. comm.

Note: All costs in 2010 dollars.

DWWSP = Davis-Woodland Water Supply Project

DWSP = Delta Water Supply Project

[a] Project Administration includes environmental and construction permitting, land acquisitions, rights of way, pre-design, agency administration and contingency, program management, water rights permits, and water supply acquisition.

[b] Other Local Costs includes costs to the water purveyor not included in the project, but necessary to integrate the project into the existing infrastructure.

Based on the estimated costs of these two projects, the planning, design, management, and construction of facilities needed to develop 33,600 AF/y (DWSP) and 45,000 AF/y (DWWSP) of new surface water resources in the Delta would be an estimated $337 million and $234.7 million, respectively. These examples of costs for developing new water supplies do not represent potential total costs if all water purveyors in the southern Delta portion of the plan area were to develop new, higher-quality water supplies. To potentially offset or reduce total project costs, the regional water boards (e.g., Central Valley Regional Water Board) and the California Department of Public Health offer grants and low-interest financing.

Salinity Pretreatment Programs

A salinity pretreatment program would target salinity loading from domestic (residential) and industrial and commercial sources in a wastewater service provider's wastewater collection system. It would provide salinity source controls at different locations within a service district to reduce the overall salt loading into the sewer system.

Domestic water similar to that found in the southern Delta may have a high concentration of minerals (typically magnesium and calcium). Water softeners are frequently used in residences to remove these minerals. During a water softener's recharge cycle, brine is used to clean the system and remove magnesium and calcium that accumulate in the mineral exchange tank. The recharge water, with suspended minerals, is then discharged to the wastewater collection system. This brine[15] and mineral solution is rarely treated at a wastewater treatment facility. By removing self-regenerating (or "automatic") water softeners and reducing salinity discharged to the wastewater collection system, salinity in the southern Delta would be expected to be reduced. Many wastewater treatment agencies operate a water softener buy-back program to remove water softeners from domestic use.

Salts also can enter the wastewater collection system as a byproduct of commercial activities, industrial processes, and food preparation activities, which can contribute to elevated salt loads entering the wastewater collection system and discharging into the southern Delta. Some commercial and industrial sources of salinity are commercial laundry facilities, food processing operations, and industrial fabrication shops. To address salinity loading by commercial and industrial dischargers, many wastewater treatment agencies prohibit commercial and industrial users from discharging to the wastewater collection system or strictly regulate the quality of wastewater entering the wastewater collection system. To improve the water quality of commercial and industrial dischargers, a variety of pollution-control methods can be used, such as best management practices (BMPs) and desalination devices, depending on the activities conducted by the commercial and industrial discharger. These methods are typically applied at the industrial or commercial business generating the wastewater.

Many wastewater treatment agencies offer rebate programs for removal of water softeners. Currently, the Inland Empire Utilities Agency (IEUA), and the Los Angeles County Sanitation Districts (LACSD) offer $206–$2,000 to homeowners to remove water softeners. Rules for each agency's programs differ, but in general, once a homeowner certifies that the water softener is removed (and it is later verified by the wastewater treatment agency), the wastewater treatment agency will reimburse the homeowner for the cost of removal.

If a wastewater treatment agency anticipates replacing 2,000 water softeners over 5 years, the agency can reasonably expect to pay between $928,600 and $9,015,400 over a period of 5 years ($185,720–$1,803,080 per year). If a commercial and industrial discharger decides to install a desalination device, costs would vary based on what is being discharged, the volume, and the desired water quality entering the wastewater collection system. For example, some light commercial reverse osmosis (RO) filtration systems cost as little as $1,000 to install and $200 per year to operate.

Desalination

Some wastewater treatment agencies may opt to remove salts at the WWTP before treated effluent is discharged to the southern Delta. Conventional wastewater treatment processes do not significantly remove salts from the wastewater treatment stream. To remove salts, a discharger must desalinate treated wastewater effluent. Methods to desalinate water at WWTPs include thermal separation, electro-dialysis, and RO. RO is analyzed here because it is the most common

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[15] *Brine* is the saline solution prevented from traveling through an RO filter.

desalination technology in California and is comparable or less expensive than other desalination methods (e.g., ion exchange, distillation).

The costs of RO include the costs associated with constructing the RO facilities and operating and maintaining facilities associated with energy and brine disposal. Brine's salinity is a function of the quality and volume of the influent into the RO filter and the efficiency of the RO filter. For example, if the influent water had 75,000 pounds of salt per 10 million gallons per day, and the RO filter was 85 percent efficient, the brine would contain 75,000 pounds of salt per 1.5 million gallons of RO filter reject water (or a 5 percent saline brine solution).

The cost to install a desalination system at a WWTP is highly variable. Important factors include: the quality and quantity of water entering the desalination system, the desired water quality leaving the desalination system, energy costs, the chosen method of desalination, and the brine disposal method. Some WWTPs only would need to treat a portion of the influent wastewater to achieve effluent limitations for salinity, which would reduce costs.

DWR's California Water Plan Update 2009 discusses the costs of desalination, which are summarized in Table 20.4.1-2.

Table 20.4.1-2. California Water Plan Update 2009 Unit Cost of Desalination

	Total Water Cost ($/AF)	
Type of Desalting	Low	High
Groundwater	500	900
Wastewater	500	2,000
Seawater	1,000	2,500

Source: Chapter 16, *Evaluation of Other Indirect and Additional Actions,* Table 16-29.

AF = acre-feet.

Using the unit cost approximations in Table 20.4.1-2, a 10 million-gallon-per-day discharger could expect to pay between $5 and $22 million to construct an RO system at a WWTP. The unit cost for constructing and operating different desalination systems are not linear, however, because the associated administrative, engineering, and legal costs do not generally decrease for smaller projects. Larger RO facilities cost more, but the typical unit price of water produced decreases due to the scale of construction costs compared to administrative, engineering, and legal costs.

Agricultural Return Flow Salinity Control

Real-time management of agricultural return flow, such as changing the timing of the release of agricultural discharge to receiving waters, is the potential method of compliance for agricultural water users that must comply with numeric salinity objectives. This method may reduce salinity entering the southern Delta.

Agricultural dischargers could monitor receiving water's assimilative capacity on a real-time basis, and time discharges to coincide with periods of high flow (i.e., more assimilative capacity). This potential method of compliance with proposed salinity standards would require dischargers to establish a network of monitoring stations and a discharge schedule. When there is no assimilative capacity, irrigators would either recycle water that would otherwise be discharged or would discharge to a detention pond until discharges to the receiving waters are permitted. This method of compliance could be integrated with other BMPs (such as water recycling or use of evaporation ponds) to reduce salinity entering the plan area.

Enhanced monitoring equipment, modeling, and forecasting capability would be needed to forecast assimilative capacity in the LSJR. Control gates and conveyance systems would also be needed to divert drainage from river discharge to permanent treatment structures when assimilative capacity is not available. Personnel would be needed to manage real-time systems and coordinate discharges from multiple subareas in the LSJR Watershed. It is assumed that there would be multiple subareas within the plan area that would manage discharges in real time, creating a real-time monitoring system. Table 20.4.1-3 estimates the components needed and costs associated with constructing a real-time management system.

Table 20.4.1-3. Costs and Components of a Real-Time Management System

Construction	
Computer and Software	$5,000
Control Gates (10)	$100,000
Floats, Weirs, and EC Monitoring Equipment	$50,000
Installation of Monitoring Components	$75,000
Conveyance to River	$100,000
Subtotal	$330,000
Contingency (30%)	$99,000
Total Construction Cost	$429,000
Operations and Maintenance	
Operations and Maintenance (Including Coordinating Discharges)	$100,000 per year

Source: Chapter 16, *Evaluation of Other Indirect and Additional Actions*, Table 16-31.

EC = electrical conductivity (salinity).

In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million).

Based on the costs identified in Table 20.4.1-3, the total estimated construction cost for 11 systems to cover the plan area is $4,719,000, with an operations and maintenance budget of $1,100,000 per year. This cost is in addition to the costs to construct and operate temporary detention ponds.

Southern Delta Temporary Barriers

The program of implementation for the SDWQ alternatives requires continued operations of the agricultural barriers at Grant Line Canal, Middle River, and Old River at Tracy, or other reasonable measures, to address the impacts of the CVP or SWP export operations on water levels and flow conditions that might affect salinity. The existing temporary barriers would likely to continue to operate in the southern Delta under the program of implementation. The purpose of operating the temporary barriers is to protect salmon migrating through the Delta and provide an adequate agricultural water supply in terms of quantity, quality and channel water levels to meet the reasonable and beneficial needs of water users in the southern Delta area. The program is operated by DWR, which also takes actions to protect agricultural diversions that do not benefit from the adverse effects of operations of the barriers. As described in Chapter 16, *Evaluation of Other Indirect and Additional Actions*, the program consists of four rock barriers across southern Delta channels that primarily benefit migrating fish or agricultural water users. DWR posts a standing schedule for the operation of the barriers.

According to DWR, water levels and water circulation in the southern Delta have improved since installation of the agricultural barriers. Migration conditions for salmon have improved since the HOR barrier was installed. As such, DWR determined it is essential to continue barrier installations.

As indicated in Chapter 16, DWR recently awarded a contract to construct and remove the temporary rock barriers, including other related construction activities for approximately $7.5 million; this cost does not include preparation of environmental studies.

Low-Lift Pumping Stations

The program of implementation for the SDWQ alternatives requires additional studies and monitoring of the southern Delta circulation and water levels. It is possible that additional study and monitoring would determine the need for modifying the existing South Delta Temporary Barriers Project. If this determination is made by the State Water Board, DWR may be required to install low lift pumping stations at the temporary barriers as a method of compliance.

As described in Chapter 16, *Evaluation of Other Indirect and Additional Actions,* a cost and environmental evaluation was prepared by DWR in 2011 for the Low-Head Pumping Conceptual Plan that identifies installation of either permanent or temporary pumps at the southern Delta temporary barriers. Estimated cost ranges were based on different site layout configurations. The site layout that would provide the greatest reduction in water quality violations is a two-pumping site alternative with 1,000 cfs combined pumping capacity at Middle and Old River barriers. The capital cost of this layout is estimated to range from $55.5–$540.7 million, and annual operation and maintenance costs are estimated to range from $4.5–$62.7 million.

20.4.2 Effects on Ratepayers and the Regional Economy

As discussed more fully in Chapter 13, *Service Providers*, existing WWTPs are point source dischargers of salt into the southern Delta, influencing the southern Delta salinity. The following WWTPs,[16] all of which are required to comply with effluent limitations established by the NPDES permits, discharge into the southern Delta. These WWTPs, their NPDES wastewater discharge permit order numbers, and their receiving water bodies are identified in Table 13-7 in Chapter 13.

- City of Tracy WWTP: 16 mgd permitted discharge.
- Manteca Wastewater Quality Control Facility: 17.5 mgd permitted discharge.

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[16] As discussed in Chapter 13, *Service Providers*, while Discovery Bay Community Services District (CSD) is very close to the southern Delta, it is not expected to result in any modifications or new construction to its facility. This is because of the large dilution in Old River and the good quality water in Old River coming down from the Sacramento River (Marshall pers. comm. 2012). Therefore, the Central Valley Water Board has determined the discharge from Discovery Bay CSD does not have reasonable potential to cause or contribute to an exceedance of the Bay-Delta water quality objectives in Old River (Marshall pers. comm. 2012). Thus, they can comply with the water quality objectives and do not need effluent limits based on the Bay-Delta water quality objectives (Marshall pers. comm. 2012). Accordingly, Discovery Bay CSD is not further included in the analysis.

- Stockton Regional Wastewater Control Facility: 55 mgd permitted discharge.
- Mountain House CSD WWTP: 5.4 mgd permitted discharge.

Ratepayer Effects

Costs to WWTP operators to comply with NPDES permit discharge limitations could result in rate increases for utility ratepayers. Assessing how sewer utility rates could be affected by compliance with salinity objectives is complicated by several uncertainties. To assess potential ratepayer impacts, the specific actions to be taken by each wastewater treatment agency to meet salinity objectives must be determined. As discussed previously, the decision that each discharger might make could include some or all of the following actions: (1) developing new surface water supplies, (2) developing and enforcing a salinity pretreatment program, and/or (3) developing desalination processes at WWTPs. These decisions, which have different cost implications, would be made by individual wastewater treatment agencies based on numerous considerations, including the needs of their service districts, availability of surface water and land, and specific operation of their wastewater facilities. Regional Water Boards are precluded from specifying the manner of compliance under Water Code Section 13360, so each wastewater treatment agency must choose for itself the appropriate mix of actions to meet its discharge requirements.

Once individual wastewater treatment agencies have decided on the proper combination of salinity control measures and the design and scale of the actions, the costs to implement an agency's compliance program to address salinity objectives under each SDWQ alternative would become apparent. Without knowing which actions an agency would take as part of its compliance strategy, estimating compliance costs is not feasible. However, once total costs associated with the compliance actions have been estimated, each individual agency would need to determine how these costs would be recovered (e.g., increasing utility rates for customers)

For example, as described in the City of Manteca's *Draft Sewer Rate Study* (2008), sewer rates for ratepayers are determined based on a systematic analysis of the contribution of sewerage made by different land uses and of the costs required to collect and treat sewer influent. The allocation of collection and treatment costs between customer categories is based on a combination of estimated usage and actual sewer influent. Sewer expenditures generally include the following categories.

- Collection operating and maintenance costs.
- Treatment operating and maintenance costs.
- Debt service (existing and projected).
- Capital replacement.
- Depreciation.
- Operating reserves/contingency.

Once the collection and treatment costs are allocated to the different customer categories, rates are determined by dividing the allocated costs by the number of users in each category. Customer categories generally include residential, commercial, industrial, and public users.

The southern Delta dischargers that could be affected by the SDWQ salinity alternatives are communities that, to varying extents, serve a mix of residential, commercial, and industrial users, with service area populations ranging from the relatively small residential community of Mountain

House (population 10,000) to the relatively large urban service area of the Stockton Regional Wastewater Control Facility (population 280,000). For each wastewater treatment agency, potential rate increases attributable to compliance with salinity objectives would be spread among user groups depending on each group's contribution to sewer system influent. Generally, rates for each user group could be expected to increase similar to the percentage increase in wastewater treatment agency budgets to achieve salinity objectives under the SDWQ alternatives, as described below.

No Project Alternative (LSJR/SDWQ Alternative 1)

Under existing conditions, the following existing wastewater treatment plant dischargers (service providers), meet amended NPDES permit requirements or are currently exempted from requirements, as described in Section 13.2.3, *Southern Delta,* of Chapter 13, *Service Providers:* the City of Tracy, the City of Stockton, the City of Manteca and Mountain House CSD. Two possible scenarios could occur under the No Project Alternative for these providers: no change to NPDES permits or a change. If, under the No Project, there would be no change to the NPDES permits the No Project Alternative would not cause the need for expansion of existing facilities or infrastructure and would not cause significant environmental effects. However, if the litigation in City of *Tracy v. California State Water Resources Control Board* is resolved in a manner that allows for the application of the Delta salinity objectives to municipal wastewater dischargers, existing wastewater treatment plant dischargers, such as the City of Tracy, the City of Stockton, the City of Manteca, and Mountain House CSD would likely be unable to meet the current 2006 Bay-Delta Plan salinity objective of 0.7 dS/m from April to August based on current effluent discharge concentrations and past violations (Tables 13-8, 13-9, and 13-20). City of Tracy, City of Stockton, and Mountain House CSD would also likely not meet the current 2006 Bay-Delta Plan salinity objective of 1.0 dS/m from September – March (Tables 13-8, 13-9, and 13-20. Therefore, it is expected that these wastewater treatment providers would potentially exceed wastewater treatment requirements during some parts of the year such that new wastewater treatment facilities, or expansion of existing facilities or infrastructure could result, the construction or operation of which could result in increased costs to ratepayers.

SDWQ Alternative 2

As discussed in Chapter 13, *Service Providers*, the City of Tracy, the City of Stockton, and Mountain House CSD would not be expected to meet the salinity objectives under SDWQ Alternative 2. As such, SDWQ Alternative 2 is anticipated to require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction or operation of which could result in increased costs to ratepayers.

SDWQ Alternative 3

As discussed in Chapter 13, *Service Providers*, all of the WWTPs would be expected to comply with the SDWQ Alternative 3 without new or modified facilities. Consequently, there would be no effects on ratepayers.

Regional Economic Effects

Although the amount that sewer rates could increase in response to expenditures by wastewater treatment agencies to achieve salinity objectives under SDWQ Alternative 2 is uncertain, any increase in sewer utility rates could shift a portion of the spending by residential ratepayers from purchases of consumer goods and services to monthly sewer utility bills. From the perspective of the regional economy of the southern Delta region, this shift, while somewhat speculative and not anticipated to be a large percentage of overall consumer spending in the region, could result in relatively small reductions in sales, employment, and income in consumer-serving sectors of the regional economy, such as retail stores and consumer-service businesses. Similarly, increases in sewer utility rates for commercial and industrial ratepayers could shift business spending from wages, supplies, and services to expenditures on higher sewer utility bills. This shift in spending could result in slightly higher prices for goods and services provided by commercial and industrial businesses, and potential reductions in employment by affected businesses. In both cases, reductions in consumer and business spending on goods and services could have ripple effects throughout the regional economy. These effects would be concentrated within the service areas of the City of Tracy, the City of Stockton, and Mountain House CSD, which are potentially affected by the SDWQ Alternative 2 and the City of Tracy, the City of Stockton, the City of Manteca, and Mountain House CSD, which could potentially be affected by the No Project Alternative.

To some extent, the adverse effects on the regional economy would be offset by increased employment generated by wastewater treatment agencies as these agencies spend to construct and operate facilities, and to establish and operate programs to achieve salinity objectives under the alternatives. These agencies and its employees would contribute to economic activity in the regional economy, directly and indirectly generating sales, employment, and income in businesses that provide good and services in the region.

The net change in regional economic activity from potentially higher sewer utility rates and from increased agency spending is not anticipated to be substantial because changes would largely represent regional shifts in sales, employment, and income rather than overall reductions in regional economic activity.

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Chapter 21
Drought Evaluation

21.1 Introduction

All Californians have confronted numerous challenges associated with the reduced water supplies available during the current drought. The State Water Resources Control Board (State Water Board) has taken extraordinary actions in response to the drought, including curtailing water rights, imposing statewide urban water conservation measures, and issuing Temporary Urgency Change Petition (TUCP) orders to modify flow and other requirements in the Delta and elsewhere under various water rights. This chapter uses Water Supply Effects (WSE) model simulations to compare drought years during the 1922–2003 analysis period to the more recent period of 2004–2015, specifically to the recent drought years of 2012–2015, to assess the severity of water supply effects during recent drought conditions compared to the severity of water supply effects during the 1922–2003 analysis period. In addition, this chapter includes a comparison of water supply availability and other water parameters during drought periods under baseline conditions and under the Lower San Joaquin River (LSJR) alternatives. These analyses show that: (1) water supply effects during drought conditions are adequately characterized by the WSE model during the 1922–2003 analysis period, (2) the runoff and water supply effects during the recent period of 2004–2015 are not inconsistent (i.e., more extreme) than drought conditions during the prior historical record, and (3) there are reductions in water supply diversions in many years under the different LSJR alternatives compared to baseline, particularly during dry years.

The following definitions are provided to understand the discussion in this chapter.

- A *dry year* or *dry period* is described as one or more years with less-than-average runoff. More than half of the years in California are identified as dry years because much greater than average runoff in a few wet years increases the average runoff compared to the median runoff (half of the years with less runoff).
- The *runoff deficit* is the difference between the average runoff and the annual runoff within a single water-year (e.g., October–September). Each dry year has a runoff deficit.
- A *water supply diversion deficit* is the difference between the normal full water supply diversions and the available water supply diversions during the water year (WY).
- A *drought year* or *drought period* is defined as one or more years with less-than-normal full diversions for water supply, reflecting a dry year or dry year period that is severe enough to cause a water supply deficit of a specified magnitude (e.g., <80 percent of full diversions).
- *Carryover storage* is the quantity of water remaining in storage in a reservoir at the end of the WY (end-of-September), before refilling from rain and snowmelt begins, and after the end of the primary water use period. Carryover storage is an important metric for evaluating water supplies during a series of dry year(s) because reservoir storage is typically reduced during dry years to provide normal full water supply deliveries. Multiple dry years may result in a cumulative runoff deficit severe enough to reduce carryover storage such that there is also a water supply diversion deficit.

- The *maximum carryover storage* is defined as the maximum end-of-September storage that provides adequate storage capacity for flood control purposes, and the *carryover storage drawdown* is defined as the maximum carryover storage minus the actual carryover storage.

This chapter identifies dry years and dry periods from 1922–2015 and evaluates how they affect water supply. The severity of a multi-year dry period depends on two factors: (1) the duration of the dry period (i.e., consecutive years with less-than-average runoff), and (2) the cumulative runoff deficit (total of runoff deficits during the dry period). The severity of dry periods was, therefore, identified by the duration, in years, and the cumulative runoff deficit, in thousand acre-feet (TAF). Each tributary was evaluated separately, but the similarities in the dry year periods for the three tributaries were identified and described. The effects of dry years on water supply were different for each tributary because the average runoff, reservoir storage, normal full diversions for water supply, and required flow releases were different for each tributary. Generally, the ratios of factors, such as storage/runoff, water supply/runoff, and required flow releases/runoff, govern the severity of the reservoir storage drawdowns and water supply deficits on the three tributaries. The historical reservoir operations and historical water supply diversions were reviewed to compare to WSE baseline reservoir operations and water supply diversions during dry year periods. The WSE baseline results for carryover storage and water supply diversions generally match historical conditions for the years post-construction of the major reservoirs. As such, the WSE model results adequately characterize the ability of reservoir storage in each tributary to reduce drought effects, with different drought effects depending on the storage/runoff and normal full diversion/runoff ratios for each tributary. The comparison of historical conditions is described in Sections 21.6 to 21.9 in this chapter.

As described in Appendix F.1 *Hydrologic and Water Quality Modeling*, the WSE model was developed to evaluate the effects of changed instream flow requirements on water supply and other parameters. Some inputs to the WSE model were based on information from the San Joaquin Module of CALSIM between 1922 and 2003. To better understand the effects for the more recent time period (from 2004–2015), the WSE model was extended using the historical reservoir inflows and estimated monthly data for downstream local inflows, return flows, and water supply diversions, using CALSIM inputs from years with similar hydrology. Adding this time period to the WSE-simulated time period allowed two additional dry periods to be included, 2007–2009 and 2012–2015. The incorporation of 2004–2015 allowed an evaluation of the effects of the LSJR alternatives on reservoir operations, water supply, and river temperatures for the most recent years, including conditions during the recent dry periods. The 2012–2015 dry year period was similar to other 4-year dry year periods in the historical record, with drought effects (reduced normal full water supply diversions) increasing in each year of the dry period. Historical and WSE-simulated operations during the two recent dry periods (2007–2009 and 2012–2015) were similar, and the WSE-simulated operations for dry periods between 1922 and 2003 were also similar to the WSE-simulated operations for the two recent dry periods.

Chapter 2, *Water Resources*, and Chapter 5, *Surface Hydrology and Water Quality*, provides additional hydrological information for each tributary. The sections below focus on the analysis and discussion of water supply effects in drought years (less than full normal water supply diversions).

21.2 Tributary Runoff and Droughts

This section compares the tributary dry periods and droughts (water supply effects) by evaluating the annual runoff and the corresponding February–June runoff for the 1921–2015 period of record. It also describes the different water user's (i.e., water or irrigation districts) responses to recent dry year periods (i.e., droughts).

The California Department of Water Resources (DWR) has published a summary of the monthly unimpaired runoff for the Central Valley streams for WY 1921–2014 (DWR 2016). California Data Exchange Center records were used to update the monthly runoff through September 2015 (WY 2015).

Table 21-1 presents a summary of the cumulative distributions of the annual runoff, February–June runoff, and February– June fraction of annual runoff for the three eastside tributaries.[1] This information is used to summarize and compare runoff and dry year periods, particularly for the February– June period that is subject to the LSJR alternatives. This chapter describes years with lower than average runoff. The average runoff is between the 50th and 60th cumulative distribution percentiles for each of the tributaries.

Table 21-1. Cumulative Distributions of Annual (WY) and February–June Unimpaired Runoff and the February–June Fraction of Runoff for the LSJR Tributaries for 1921–2015 (95 years)

Percentile	Stanislaus Annual Runoff (TAF)	Stanislaus Feb-Jun (TAF)	Stanislaus Feb-June (fraction)	Tuolumne Annual Runoff (TAF)	Tuolumne Feb-Jun (TAF)	Tuolumne Feb-Jun (fraction)	Merced Annual Runoff (TAF)	Merced Feb-Jun (TAF)	Merced Feb-Jun (fraction)
Min	155	135	0.87	384	327	0.85	151	127	0.84
10	446	362	0.81	825	667	0.81	388	321	0.83
20	591	485	0.82	1,026	856	0.83	479	389	0.81
30	649	548	0.85	1,128	963	0.85	550	463	0.84
40	823	686	0.83	1,368	1,128	0.82	644	553	0.86
50	1,075	807	0.75	1,685	1,283	0.76	836	639	0.76
60	1,236	982	0.79	2,022	1,547	0.76	1,037	786	0.76
70	1,356	1,072	0.79	2,164	1,687	0.78	1,154	916	0.79
80	1,570	1,178	0.75	2,519	1,863	0.74	1,414	1,047	0.74
90	1,922	1,493	0.78	3,118	2,219	0.71	1,727	1,274	0.74
Max	2,954	1,994	0.67	4,630	2,887	0.62	2,790	1,830	0.66
Average	1,107	857	0.77	1,829	1,384	0.76	946	731	0.77

Source: DWR 2016.

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[1] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

The cumulative distributions of annual unimpaired runoff for the three eastside tributaries, expressed as a fraction of the mean annual runoff for 1921 to 2015, are shown in Table 21-2. The water supply conditions, defined using the fraction of average runoff, are nearly identical for the three eastside tributaries. The full water supply diversions and the maximum carryover storage can be expressed as the fraction of average runoff; the effects of dry year periods on water supply reductions (diversion deficits) depend on these diversion/runoff and carryover storage/runoff fractions.

The Stanislaus River average WY runoff was 1,107 TAF, and the average February–June runoff was 857 TAF. The reduced runoff in dry years is of particular interest for the drought analysis; the minimum runoff was 14 percent of average runoff; runoff in 10 percent of the years was less than 45 percent of average runoff; runoff in 20 percent of the years was less than 53 percent of average runoff; runoff in 30 percent of the years was less than 59 percent of average runoff; and runoff in 40 percent of the years was less than 74 percent of average runoff. The WSE model showed average full water supply diversion for the Stanislaus River was 651 TAF (59 percent of average runoff), and the maximum carryover storage in New Melones Reservoir is 2,000 TAF (180 percent of average runoff).

The Tuolumne River average WY runoff was 1,829 TAF, and the average February–June runoff was 1,384 TAF. The minimum runoff was 21 percent of average runoff; runoff in 10 percent of the years was less than 45 percent of average runoff; runoff in 20 percent of the years was less than 56 percent of average runoff; runoff in 30 percent of the years was less than 58 percent of average runoff; and runoff in 40 percent of the years was less than 75 percent of average runoff. Because the City and County of San Francisco (CCSF) diversions of 250 TAF are upstream of New Don Pedro Reservoir, the downstream diversions and carryover storage are expressed as the fraction of the average annual inflow to New Don Pedro Reservoir (i.e., average annual runoff minus 250 TAF). The WSE model showed average full water supply diversion for the Tuolumne River was 901 TAF (57 percent of average runoff to New Don Pedro Reservoir), and the maximum carryover storage is 1,700 TAF (108 percent of average runoff to New Don Pedro Reservoir).

The Merced River average WY runoff was 946 TAF, and the average February–June runoff was 731 TAF. The minimum runoff was 16 percent of average runoff; runoff in 10 percent of the years was less than 41 percent of average runoff; runoff in 20 percent of the years was less than 51 percent of average runoff; runoff in 30 percent of the years was less than 59 percent of average runoff; and runoff in 40 percent of the years was less than 68 percent of average runoff. The WSE model showed average full water supply diversion for the Merced River was 632 TAF (67 percent of average runoff) and the maximum carryover storage in Lake McClure is 850 TAF (90 percent of average runoff).

Table 21-2. Cumulative Distributions of Annual (WY) and February–June Unimpaired Runoff as Fraction of Average Runoff for the for the LSJR Tributaries for 1921–2015 (95 years)

Percentile	Stanislaus Runoff (fraction)	Stanislaus Feb–Jun (fraction)	Tuolumne Runoff (fraction)	Tuolumne Feb–Jun (fraction)	Merced Runoff (fraction)	Merced Feb–Jun (fraction)
Min	0.14	0.16	0.21	0.24	0.16	0.17
10	0.40	0.42	0.45	0.48	0.41	0.44
20	0.53	0.57	0.56	0.62	0.51	0.53
30	0.59	0.64	0.62	0.70	0.58	0.63
40	0.74	0.80	0.75	0.82	0.68	0.76
50	0.97	0.94	0.92	0.93	0.88	0.87
60	1.12	1.15	1.11	1.12	1.10	1.08
70	1.23	1.25	1.18	1.22	1.22	1.25
80	1.42	1.37	1.38	1.35	1.50	1.43
90	1.74	1.74	1.71	1.60	1.83	1.74
Max	2.67	2.33	2.53	2.09	2.95	2.50
Average (TAF)	1,107	857	1,829	1,384	946	731
Average Full Water Supply Diversions	651 (59%)		901 (57% of effective inflow[a])		632 (67%)	
Carryover Storage	2,000 (180%)		1,700 (108% of effective inflow[a])		850 (90%)	

Source: Calculated from DWR 2016.

[a] For the Tuolumne River, effective inflow is 1,829 TAF/y minus 250 TAF/y removed upstream of New Don Pedro Reservoir by City and County of San Francisco.

Table 21-2 shows that unimpaired runoff in each tributary was less than 75 percent of average runoff in 4 out of 10 years (40 percent of years), and the runoff was less than 50 percent of average runoff in 2 out of 10 years (20 percent of years). Potential drought consequences under the baseline and LSJR alternatives would be different for each tributary because of different average full diversions and different maximum carryover storages relative to the average runoff. The annual baseline water supply deficits (i.e., droughts) were, therefore, slightly different for each tributary. The runoff and dry year periods for each river are described below using information from Tables 21-1 and 21-2 and graphically depicted in several figures. The potential for drought (water supply deficits), as a result of reduced runoff and reduced carryover storage in the reservoirs, is also discussed below.

The ability of surface water users in the three eastside tributaries to manage drought conditions varies and depends on numerous factors including, but not necessarily limited to, reservoir carryover storage and availability of non-surface water sources. Typically, the potential consequences for drought are more severe as the cumulative runoff deficits increase over a longer duration. Numerous dry years typically leads to greatly reduced storage and diversions. The sections that follow document some of the recent actions that water users in the three tributaries have taken during the 2012–2015 drought period. For more information regarding the water users and various applicable groundwater management plans and agricultural water management plans

(AWMPs), please refer to Chapters 2, *Water Resources*, Chapter 5, *Surface Hydrology and Water Quality*, Chapter 9, *Groundwater Resources,* and Chapter 13, *Service Providers*.

21.3 Stanislaus River

21.3.1 Runoff

The average runoff on the Stanislaus River (1921–2015) was 1,107 thousand acre feet per year (TAF/y) and the runoff was less than average in about half the years (50 out of 95 years), was less than 50 percent of average in 16 years, and was less than 25 percent of average in 2 years (1924 and 1977) (Table 21-1). The WY runoff could be used to classify five categories (20 percent of years in each). As an example, critical years (lowest 20 percent of years) would have runoff of less than 591 TAF/y (0.53 average); dry years (next lowest 20 percent of years) would have runoff of less than 823 TAF/y (0.74 average); below-normal years (middle 20 percent of years) would have runoff of less than 1,236 TAF/y (1.12 average); above-normal years (second highest 20 percent of years) would have runoff of less than 1,570 TAF/y (1.42 average); and wet years (highest 20 percent of years) would have runoff of greater than 1,570 TAF/y. The runoff in 2014 (370 TAF) and 2015 (330 TAF) were both less than half of average, but runoff has been lower in a few previous years. In lower runoff years, the February–June runoff was more than 80 percent of the total Stanislaus River runoff (Table 21-1). In wet years, rainfall runoff in December or January and snowmelt in July reduced the fraction of runoff in February–June to about 70 percent in some years.

Figure 21-1 shows the annual WY Stanislaus River runoff and February–June runoff, with the annual runoff deficits and the cumulative runoff deficits (consecutive years with runoff deficits, less than average runoff) shown as negative values for WY 1921–2015. About half of the years had greater than average runoff. There were several multi-year periods with less than average runoff (cumulative runoff deficits). The major dry year periods were 1924-1934, 1947-1949, 1959–1962, 1976–1977, 1987–1992, 2001–2004, 2007–2008, and 2012–2015. For the years with less than average runoff, the runoff deficits averaged about 50 percent of the average runoff (550 TAF).

For the Stanislaus River the average runoff was 1,107 TAF, and the cumulative runoff deficits generally increased by about 50 percent of average runoff for each year in the dry-year sequence (550 TAF runoff deficit per dry year). A 2-year dry period generally had a cumulative runoff deficit of about 1,100 TAF (although 1976–1977 had a deficit of 1,700 TAF); a 4-year dry period generally had a cumulative runoff deficit of 2,200 TAF (e.g., 2012–2015 had a deficit of 2,475 TAF); and a 6-year dry period generally had a cumulative runoff deficit of 3,300 TAF (e.g., 1987–1992 had a deficit of 3,600 TAF). The dry year period of 2007-2008 was typical of other historical dry periods with a cumulative runoff deficit of 1,020 TAF (46 percent of average runoff per year) and the dry year period during 2012–2015 (4 years) was typical of other historical dry periods, with a cumulative runoff deficit of 2,475 TAF, about 55 percent of average runoff each year.

Therefore, although there were more dry years with less than average runoff during the last 12 years (8 out of 12), the severity of these dry year periods (i.e., cumulative deficits) were similar to other dry year periods in the historical period of 1922–2003 used for the environmental assessment of the LSJR alternatives.

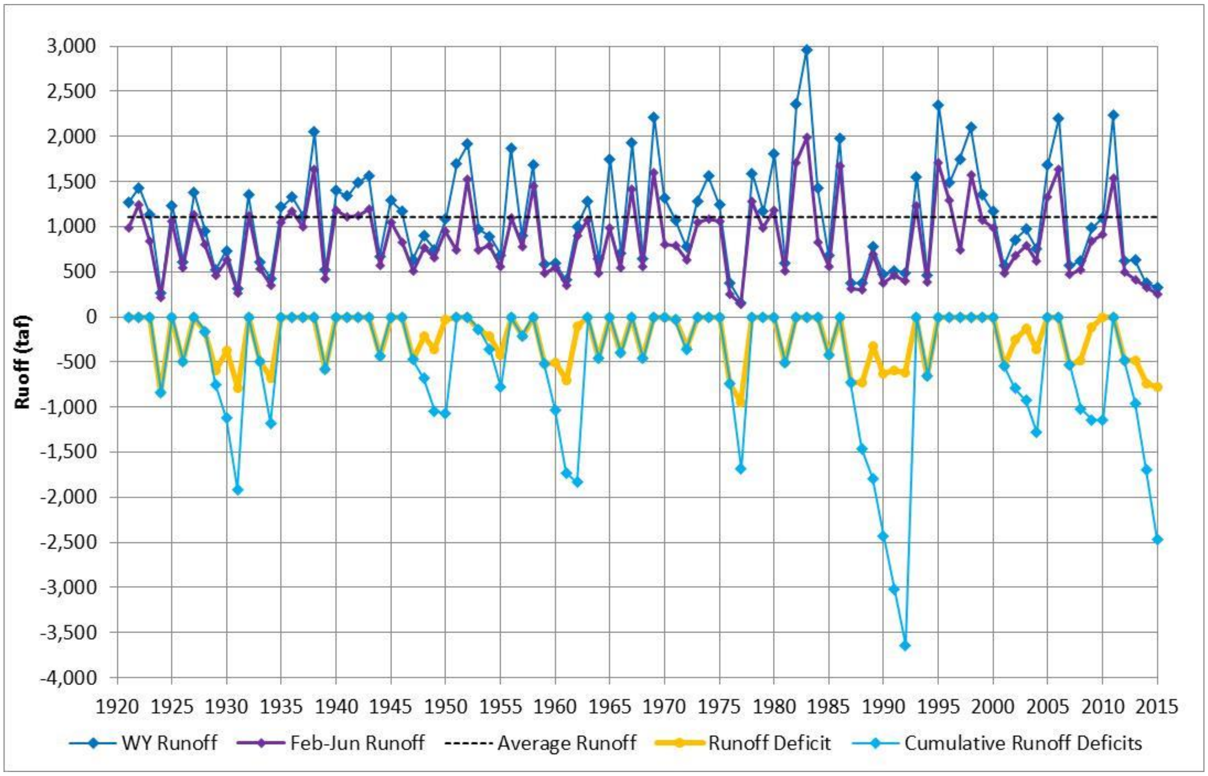

Figure 21-1. Stanislaus River Annual (WY) and February–June Unimpaired Runoff (TAF) with Annual and Cumulative Runoff Deficits for 1921–2015

21.3.2 Potential for Drought

The New Melones Reservoir has substantial carryover storage capacity of 2,000 TAF (180 percent of average runoff). Therefore, the WSE model showed average full water supply diversions of 651 TAF (59 percent of average runoff) can be maintained for several years during dry periods (Table 21-2). The upstream reservoirs on the Stanislaus River are generally operated for seasonal storage to maintain hydroelectric energy generation through the summer months. The annual inflow to New Melones Reservoir is, therefore, similar to the annual runoff.

Prior to the construction of New Melones Reservoir, minimum streamflow requirements were specified in the State Water Board's Water Right Decision 1422 (D-1422). After this decision, minimum streamflow requirements have been increased on the Stanislaus River by various agencies through different mechanisms, including: the California Department of Fish and Wildlife (formerly the California Department of Fish and Game) as part of the 1987 fisheries agreement; the Central Valley Project Improvement Act Anadromous Fish Restoration Program (AFRP); the Vernalis Adaptive Management Program (VAMP) (2000–2012), that modified the D-1641 Vernalis flows during April and May; and the National Marine Fisheries Service (NMFS) as part of its 2009 biological opinion (BO) Stanislaus River reasonable and prudent alternative (RPA), including Action 3.1.3 (NMFS BO). The five flow schedules identified by NMFS in Appendix 2E of the BO (NMFS 2009) are applied depending on a combination of runoff and storage; the minimum release flows require 185 TAF (dry years), which is 17 percent of the average runoff, and the maximum release flows require 590 TAF (wet years), which is 54 percent of the average runoff.

The recent drought (2012–2015) provides evidence of the importance of the New Melones Reservoir carryover storage for full water supply diversions on the Stanislaus River. The carryover storage was full (2,000 TAF) in 2011 and was reduced by about 500 TAF in 2012, 2013, and 2014 (with relatively high diversions of about 550 TAF each year). The carryover storage at the end of WY 2014 was about 520 TAF. The low runoff conditions again in 2015 resulted in reduced diversions (425 TAF) and very low carryover storage (267 TAF).

Allocating more of the Stanislaus River runoff for streamflow requirements over time has generally reduced the potential refilling of New Melones reservoir in normal and wet years. This has generally caused greater carryover storage drawdowns in dry years. The baseline drought conditions assessed with the WSE model were small (less than 5% of years with less than 80 percent of full diversions), but increased flows under the LSJR alternatives and deliveries of full contract amounts in more years would likely increase the severity of drought conditions (more years with greater diversion deficits) for the Stanislaus River (Table 21-3).

21.3.3 Drought Water Management

The Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID) both have prepared AWMPs that include the efficient water management practices required by the 2009 Water Conservation Bill. They both have water resources plans to improve the operational efficiency and encourage water conservation measures within the districts. OID and SSJID have developed drought bulletins in 2015 for informing their users of activities related to the drought. The emergency drought bulletin explains,

> The two districts have been in negotiations with the federal Bureau of Reclamation (which operates New Melones Reservoir), the National Marine Fisheries Service and the State Water Resources Control Board (SWRCB), urging the approval of a Temporary Urgency Change Petition to…provide for springtime ‘pulse flows’ for steelhead and salmon on the Stanislaus, base flows for the fish in the river through December, and adequate supplies of water for each district, given serious conservation measures both districts are taking (SSJID 2015).

This type of management proposal is anticipated to maintain enough water in New Melones Reservoir at the end of September (irrigation season) to meet flows for spawning salmon through December 31 (SSJID 2015). The plan would also help the districts to keep Lake Tulloch (the regulating reservoir downstream of New Melones Reservoir) at normal operational levels (for recreation) through September (SSJID 2015).

SSJID drought bulletins also encourage water conservation and facilitate water allocation and private groundwater transfers within the district. The drought bulletin of April 6, 2015 includes this summary of conditions in 2015:

> The water supply picture looks increasingly grim for the coming growing season. California’s governor declared a State of Emergency throughout the state due to severe drought conditions on April 1, 2015. With very little precipitation this past winter, farmers will be relying more on pumping groundwater, having to severely conserve whatever surface water they may have available to them, potentially fallowing crops, and when possible and/or necessary, transferring water allocations between their own parcels, or to other growers’ farm operations. A limit of 36 inches of irrigation water per parcel will be in effect because the ongoing drought threatens the District’s water supply in 2015, and will most likely worsen in 2016. A 10-day rotation schedule was also confirmed. SSJID’s drought task force has already met with many of our growers to review their past year’s water consumption history (SSJID 2015).

Table 21-3. Cumulative Distribution of WSE Baseline Annual (WY) Water Supply Diversions for 1922–2015

Average Runoff (TAF)		1,107	Average Inflow (TAF)	1,577	Average Runoff (TAF)	945
Average Full Diversion (TAF)		651	Average Full Diversion (TAF)	901	Average Full Diversion (TAF)	632
Percentile	Stanislaus Baseline Diversion (TAF)	% Full Diversion	Tuolumne Baseline Diversion (TAF)	% Full Diversion	Merced Baseline Diversion (TAF)	% Full Diversion
Max	792	100	1,050	100	687	100
90	724	100	957	100	668	100
80	703	100	931	100	656	100
70	685	100	901	100	633	100
60	676	100	886	100	625	100
50	656	100	869	100	618	100
40	627	100	856	100	599	100
30	615	100	824	99	579	99
20	582	99	775	92	547	92
10	549	92	614	67	419	63
Min	268	50	392	43	137	21
Average	635	98	840	93	574	91

Water received by the Stockton East Water District (SEWD)/Central San Joaquin Water Conservation District (CSJWCD) from New Melones Reservoir through their contract with the U.S. Bureau of Reclamation (USBR) and their temporary contracts with OID/SSJID (2000–2010) has been used to reduce some of the need for groundwater pumping for irrigation and urban water supply in the SEWD/CSJWCD service areas (including the City of Stockton). SEWD/CSJWCD have developed conjunctive water management facilities in order to reduce groundwater pumping in normal years so that additional groundwater pumping can provide full water supply in drought years without reducing long-term average groundwater levels (i.e., sustainable pumping). CSJWCD, for example, has developed surface irrigation facilities for about 10,000 acres that are normally irrigated from groundwater pumping. This irrigated land uses about 30 TAF per year and reduces groundwater pumping by approximately this amount.

SEWD worked with Calaveras County to obtain additional surface water supply from Hew Hogan Reservoir on the Calaveras River. This reservoir (317 TAF storage) was completed in 1964 and provides an average yield of about 150 TAF, which reduces groundwater pumping for the land irrigated with surface water (SEWD 2014). Some fraction of this surface water infiltrates from the conveyance channels and from the irrigated lands; SEWD installs check dams along the Calaveras River, Mormon Slough, and other channels to increase the infiltration area. SEWD has developed about 50 acres of recharge ponds that have an infiltration rate of 0.5 foot/day, providing 9 TAF of annual recharge. The most recent recharge project involves winter spreading on irrigated lands downstream of the Farmington flood control dam; the full project could include 1,200 acres of land that would be flooded for 60 days each winter and provide about 35 TAF of infiltration (SEWD 2014). These conjunctive water management facilities have better prepared SEWD and CSJWCD water users for the limited surface supplies during this drought (e.g., No New Hogan Reservoir supplies were available in 2015).

Given the information provided in drought bulletins by SSJID, and as discussed in Chapter 9, *Groundwater Resources*, reductions in the surface water supply during drought years would likely result in a return to groundwater pumping for some users within the SSJID and OID service areas, and for most users within SEWD/CSJWCD. The 1998 agreement with SSJID/OID includes a drought provision; the full contract amount (600 TAF) is reduced to inflow plus 1/3 of the inflow deficit, when the inflow is less than 600 TAF. The 2014 runoff was 370 TAF, the water supply diversions were 515 TAF, and the carryover storage was 520 TAF. The 2015 runoff was 329 TAF, the water supply diversions were 425 TAF and the carryover storage was 267 TAF. No water was available for the SEWD/CSJWCD contract in 2014 or 2015.

21.4 Tuolumne River

21.4.1 Runoff

The average runoff for the Tuolumne River was 1,829 TAF/y, and the runoff was less than average in about half of the years (50 out of 95 years), was less than 50 percent of average in 15 years, and was less than 25 percent of average in 1 year (1977) (Table 21-1). The WY runoff could be used to classify five categories (20 percent of years in each). For example, critical years (lowest 20 percent of years) would have runoff of less than 1,026 TAF/y (0.56 average); dry years (next lowest 20 percent of years) would have runoff of less than 1,368 TAF/y (0.75 average); below-normal years (middle 20 percent of years) would have runoff of less than 2,022 TAF/y (1.11 average); above-normal years (second highest 20 percent of years) would have runoff of less than 2,519 TAF/y (1.38 average); and wet years (highest 20 percent of years) would have runoff of greater than 2,519 TAF/y. The runoff in 2014 (601 TAF) and 2015 (602 TAF) were less than 40 percent of average; runoff has been similar in a few previous years. In lower runoff years, the February–June runoff provided more than 80 percent of the total Tuolumne River runoff (Table 21-1). In wet years, rainfall runoff in December or January and snowmelt in July reduced the fraction of runoff in February–June to about 75 percent in some years.

Figure 21-2 shows the annual WY Tuolumne River runoff and February–June runoff, with the annual runoff deficits and the cumulative runoff deficits (consecutive years with runoff deficits) shown as negative values for WYs 1921–2015. About half of the years had greater than average runoff. There were several multi-year dry periods with less-than-average runoff (cumulative runoff deficits). The major dry periods were 1924–1934, 1947–1949, 1959–1962, 1976–1977, 1987–1992, 2001–2004, 2007–2008, and 2012–2015. For the years with less than average runoff, the runoff deficits averaged about 50 percent of the average runoff (915 TAF). These were the same dry years as identified for the Stanislaus River because the precipitation patterns (i.e., rainfall and snowfall) are nearly identical for these two watersheds.

For the Tuolumne River the average runoff was 1,829 TAF, and the cumulative runoff deficits generally increased by about 50 percent of average runoff for each year in the dry-year sequence (915 TAF runoff deficit per dry year). A 2-year dry period generally had a cumulative runoff deficit of about 1,830 TAF (although 1976–1977 had a deficit of 2,600 TAF); a 4-year dry period generally had a cumulative runoff deficit of 3,660 TAF (e.g., 2012–2015 had a deficit of 4,150 TAF); and a 6-

year dry period generally had a cumulative runoff deficit of 5,500 TAF (e.g., 1987–1992 had a deficit of 5,400 TAF). The dry year period of 2007–2008 was typical of other historical dry periods with a cumulative runoff deficit of 1,675 TAF (46 percent of average runoff per year) and the dry year period during 2012–2015 (4 years) was typical of other historical dry periods, with a cumulative runoff deficit of 4,143 TAF, about 55 percent of average runoff each year.

Therefore, although there were more dry years with less than average runoff during the last 12 years (8 out of 12), the severity of these dry year periods (i.e., cumulative deficits) were similar to other dry year periods in the historical period of 1922–2003 used for the environmental assessment of the LSJR alternatives.

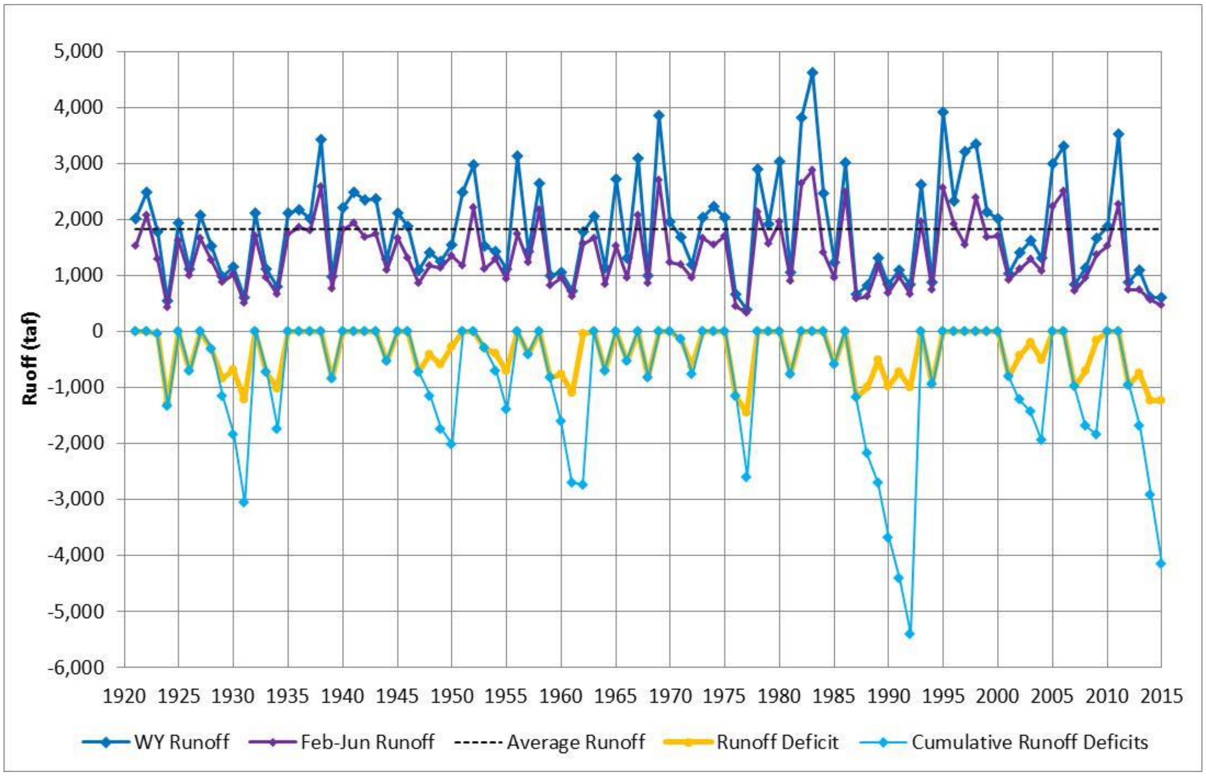

Figure 21-2. Tuolumne River Annual (WY) and February–June Unimpaired Runoff (TAF) with Annual and Cumulative Runoff Deficits for 1921–2015

21.4.2 Potential for Drought

The New Don Pedro Reservoir has a large carryover storage maximum of 1,700 TAF (93 percent of average runoff). Because the CCSF water supply diversions of about 250 TAF/y are upstream of New Don Pedro Reservoir, this drought evaluation for the Tuolumne River assumes that the effective runoff (New Don Pedro inflow) was reduced each year by the 250 TAF upstream diversion. Therefore, the average annual inflow to New Don Pedro Reservoir was 1,579 TAF, the maximum carryover storage is about 108 percent of average inflow, and the WSE model showed average full water supply diversion was 901 TAF, about 57 percent of average effective inflow (Table 21-2).

Required New Don Pedro Reservoir releases for required flows were specified in the original Federal Energy Regulatory Commission (FERC) license (1966) and modified in the 1995 settlement agreement. The original FERC license required 118 TAF (8 percent of average New Don Pedro inflow) in normal years and 64 TAF (4 percent of average inflow) in dry years. The 1995 settlement (based on FERC-mandated fish investigations) increased the required flow releases to 95 TAF (6 percent of average inflow) in the driest years to a maximum of 310 TAF (20 percent of average inflow) in years with greater-than-average runoff.

Allocating more of the Tuolumne River runoff for minimum streamflow requirements has generally reduced the potential refilling of New Don Pedro Reservoir in normal and wet years, and has caused greater carryover storage drawdown in dry years. The combination of average full water supply diversions (57 percent of average inflow) and increased required flows (41 percent of average runoff for WSE baseline conditions) has increased the WSE baseline drought years (with less than 80 percent of average full diversions) to about 15 percent of the years (Table 21-3). The baseline drought conditions assessed with the WSE model were moderate (15 percent of years with less than 80 percent of average full diversions), and increased flows under the LSJR alternatives would likely increase drought conditions (more years with greater diversion deficits) for the Tuolumne River.

21.4.3 Drought Water Management

Both Turlock Irrigation District (TID) and Modesto Irrigation District (MID) have AWMPs (TID 2012; MID 2012), and both participate in regional groundwater management plans (for additional information regarding regional groundwater management plans and the irrigation districts' AWMPs see Chapters 9, *Groundwater Resources*; 11, *Agricultural Resources*; and 13, *Service Providers*). Water shortage procedures for these two irrigation districts are described in their AWMPs. The normal surface irrigation allocation for both TID and MID is 48 inches; however, these allocations were reduced in years with less-than-full water diversions. Both districts use increased groundwater pumping to augment the surface deliveries, but they have a limited number of district wells or rented (private) wells (TID 2012; MID 2012). Both districts describe their water operations as conjunctive (i.e., combination of surface water diversions and groundwater pumping), because the seepage from canals, regulating reservoirs, and infiltration from the irrigated lands results in a substantial groundwater recharge in most years (TID 2012; MID 2012).

TID's AWMP indicates that beginning in 2013, allotments were no longer to be used in water-short years; the TID Board of Directors would determine if the dry year rate schedule should be used and the amount of water available on a per-acre basis. This determination would be based on projected runoff, including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps. Groundwater pumping was expected to increase progressively in each drought year as surface supplies decreased. TID's AWMP acknowledged that even with conjunctive water management in the service area, groundwater was not an unlimited supply, and the availability of groundwater may decline over time due to declining water levels from increased pumping and reduced recharge from irrigation canals. The 2014 runoff was 601 TAF, the water supply diversions were 560 TAF, and the carryover storage was 780 TAF. The 2015 runoff was 602 TAF, the water supply diversions were 450 TAF and the carryover storage was 644 TAF.

21.5 Merced River

21.5.1 Runoff

The average runoff was 946 TAF/y, and the runoff was less than average in more than half of the years (54 out of 95 years), was less than 50 percent of average in 18 years, and was less than 25 percent of average in 1 year (1977) (Table 21-1). The WY runoff could be used to classify five categories (20 percent of years in each). For example, critical years (lowest 20 percent of years) would have runoff of less than 479 TAF/y (0.51 average); dry years (next lowest 20 percent of years) would have runoff of less than 644 TAF/y (0.68 average); below-normal years (middle 20 percent of years) would have runoff of less than 1,037 TAF/y (1.10 average); above-normal years (second highest 20 percent of years) would have runoff of less than 1,414 TAF/y (1.50 average); and wet years (highest 20 percent of years) would have runoff of greater than 1,414 TAF/y. The runoff in 2014 (239 TAF) and 2015 (175 TAF) were less than 25 percent of average; the runoff has only been this low in 1924 and 1977. In lower runoff years, the February–June runoff provided more than 80 percent of the total Merced River runoff (Table 21-1). In wet years, rainfall runoff in December or January and snowmelt in July reduced the fraction of runoff in February–June to about 75 percent in some years.

Figure 21-3 shows the annual Merced River WY runoff and February–June runoff, with the annual runoff deficits and the cumulative runoff deficits (consecutive years with runoff deficits) shown as negative values for WY 1921–2015. About half of the years had greater than average runoff. There were several multi-year periods with less-than-average runoff (cumulative runoff deficits). The major dry year periods were 1924–1934, 1947–1949, 1959–962, 1976–1977, 1987–1992, 2001–2004, 2007–2008, and 2012–2015. For the years with less than average runoff, the runoff deficits averaged about 50 percent of the average runoff (475 TAF). These were the same dry years as identified for the Stanislaus and Tuolumne Rivers because the precipitation patterns (*i.e.,* rainfall and snowfall) are nearly identical for these three watersheds.

For the Merced River, the average runoff was 945 TAF, and the cumulative runoff deficits generally increased by about 50 percent of average runoff for each year in the dry-year sequence (475 TAF runoff deficit per dry year). A 2-year dry period generally had a cumulative runoff deficit of about 950 TAF (although 1976–1977 had a deficit of 1,500 TAF); a 4-year dry period generally had a cumulative runoff deficit of 1,900 TAF (e.g., 2012–2015 had a deficit of 2,450 TAF); and a 6-year dry period generally had a cumulative runoff deficit of 2,850 TAF (e.g., 1987–1992 had a deficit of 3,000 TAF). The dry year period of 2007–2008 was typical of other historical dry periods, with a cumulative runoff deficit of 860 TAF (46 percent of average runoff per year), and the dry year period from 2012–2015 (4 years) was more severe than most historical dry periods, with a cumulative runoff deficit of about 2,460 TAF (65 percent of average runoff each year) on the Merced River.

Therefore, although there were more dry years with less than average runoff during the last 12 years (8 out of 12), the severity of these dry year periods (i.e., cumulative deficits) were similar to other dry year periods in the historical period of 1922–2003 used for the environmental assessment of the LSJR alternatives.

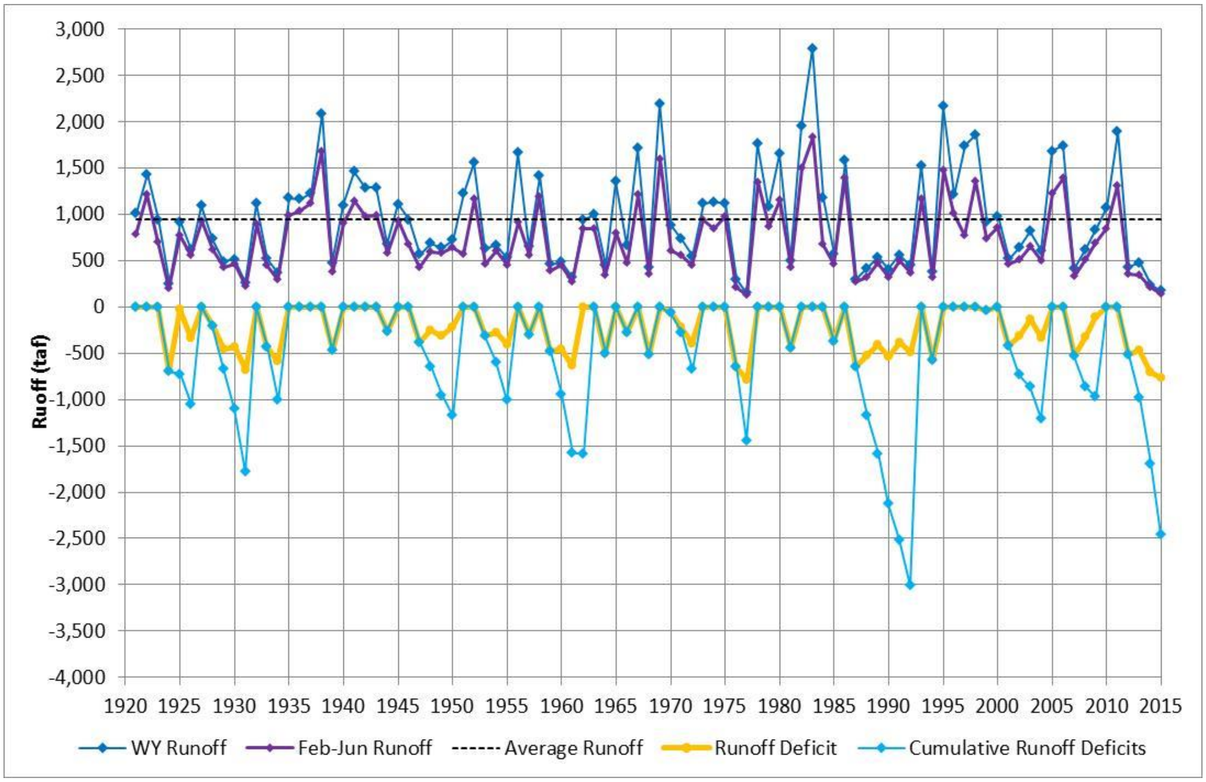

Figure 21-3. Merced River Annual (WY) and February–June Unimpaired Runoff (TAF) with Annual and Cumulative Runoff Deficits for 1921–2015

21.5.2 Potential for Drought

Lake McClure has a maximum capacity of 1,024 TAF, but the carryover storage is limited to 850 TAF (90 percent of average runoff) by the COE maximum flood-control storage. The WSE model showed average full water supply diversion for the Merced River was 632 TAF (67 percent of average runoff) (Table 21-2). Three separate agreements jointly control required minimum flows (FERC license, Cowell Diversions, and Davis-Grunsky contract). Normal year fish flow requirements are about 175 TAF (18 percent of average runoff) and dry year flow requirements are about 100 TAF (10 percent of average runoff).

The combination of average full water supply diversions (67 percent of average runoff), moderate carryover storage (90 percent of average runoff) and relatively low required release flows (17 percent of average runoff for WSE baseline conditions) increased the WSE baseline drought years (with less than 80 percent of full diversions) to about 10 percent of the years (Table 21-3). The baseline drought conditions assesses with the WSE model were moderate (15 percent of years with less than 80 percent of average full water supply diversions) and increased flows under the LSJR alternatives would likely increase drought conditions (more years with greater diversion deficits) for the Merced River.

21.5.3 Drought Water Management

The general water supply strategy for Merced ID and Merced County, to maximize surface water deliveries in order to minimize the groundwater pumping for agricultural water supply in normal years, is described in the Merced Integrated Regional Water Management Plan (RMC 2013). This plan covers approximately 600,000 acres in the northeast portion of Merced County, including the 490,000-acre Merced groundwater subbasin. The Integrated Regional Water Management Program (IRWMP) suggests that Merced ID and Merced County rely on more groundwater pumping in dry years to provide as much of the full agricultural and urban supplies as possible for all water users.

The Merced IRWMP includes several water conservation measures (urban and agricultural) and several projects to increase surface water deliveries (new pipelines and pumps) or to increase groundwater recharge (spreading basins). Two of these, the Highlands Groundwater Conservation Project and the expanded Cressey Groundwater Recharge Project were included in the 2014 IRWMP Drought Grant Application (Merced ID 2014). These two projects, which provide good examples of how Merced ID responds during dry periods, are summarized below.

The Highland Groundwater Conservation Project would deliver surface water to about 700 acres instead of pumping groundwater in normal years. During dry years when surface water diversions are limited, the existing wells would be available for pumping (i.e., conjunctive use). Merced ID has surface water supply that could be provided in this area, but infrastructure is currently not sufficient to convey water to the entire area. The water supply for this area is about 2,500 AF/y (e.g., 3.5 AF/acre); increased diversions from the Merced River would reduce groundwater pumping by this amount in most years (8 out of 10). During drought years (2 out of 10), groundwater pumping would be resumed. (Merced ID 2014.)

The Cressey Groundwater Recharge Project would expand an existing recharge basin to provide drought relief by increasing groundwater supplies in normal years in the Merced groundwater subbasin. The Cressey Recharge Basin Enlargement Project, sponsored by Merced ID, is the second phase of an ongoing recharge project. The project would enlarge the existing recharge basin from 8 acres to 13 acres. The existing recharge basin began operations in 2011 and is capable of recharging 2.75 acre-feet per acre per day (AF/y); the existing ponds recharge about 24 AF/y and the expanded ponds could recharge about 38 AF/y. The annual recharge depends on the number of days when surface water can be delivered to the ponds. The existing operations of the main canal are limited to the irrigations months. (Merced ID 2014.) The 2014 runoff was 239 TAF, the water supply diversions were 210 TAF, and the carryover storage was 122 TAF. The 2015 runoff was 175 TAF, the water supply diversions were 20 TAF, and the carryover storage was 87 TAF.

21.6 Evaluation of Recent Historical Reservoir Operations 1970–2015

The reservoirs on each of the SJR tributaries provide seasonal and multi-year storage to support seasonal water supply diversions. The reservoirs allow seasonal and carryover storage of the runoff, provide flood control benefits (temporary storage of high inflows with subsequent releases to maintain the seasonal flood control storage), allow diversions of the seasonal irrigation demands, and provide required river releases for fish habitat and downstream riparian diversions. The historical reservoir operations are described with the allocation of annual runoff for water supply diversions and carryover storage. In many years, the runoff is greater than the water supply diversions, and carryover storage is increased. Additional water can be released as flood-control releases or required river releases, as needed. In years when runoff is less than the water supply diversions, the carryover storage is reduced to supply the required river releases and water supply diversions. In years when the runoff and carryover storage is not sufficient, the water supply diversions are reduced.

The monthly WSE baseline results for 1922–2003 provide estimates of the reservoir operations for the historical runoff with the existing reservoir releases for water supply diversions, required flows for fish habitat, downstream riparian diversions, and flood control. The WSE extended baseline results (1922–2015) provide a longer period for drought evaluation, with the existing water supply diversions and fish habitat flows calculated up to 2015. The WSE baseline results are expected to more closely match the historical reservoir operations in the most recent years, when the required release flows and water supply diversions were similar to those specified in the WSE model. Because this chapter is focused on drought conditions, the extended WSE baseline water supply diversions are summarized for each tributary to indicate the potential for drought conditions. Because the WSE model calculates a different full water supply diversion for each year based on each year's water demand, the annual diversions were compared to the full diversions for each year to determine water supply deficits.

Table 21-3 summarizes the extended WSE baseline diversions for 1922–2015 for each tributary, with the diversions expressed as a fraction of the specified WSE-modeled full diversion for each year (varies by about +/- 10 percent from year to year). The cumulative distributions of the annual diversions are given in 10 percent increments (i.e., 1 out of 10 years). The average runoff and the average full diversion for each tributary are given for reference. The frequency of diversion deficits greater than 10 percent of full diversions (moderate), 20 percent of full diversions (substantial) or 30 percent of full diversions (severe) can be compared. For example, the fraction of years with less than 80 percent of full diversions (>20 percent deficit) can be compared: the Stanislaus River diversions were less than 80 percent of full diversions in about 20 percent of the years; the Tuolumne River diversions were less than 80 percent of full diversions in about 15 percent of the years (interpolated from the 20 percent and 10 percent values); and the Merced River diversions were less than 80 percent of full diversions in about 15 percent of the years (interpolated from the 20 percent and 10 percent values). The recent historical reservoir operations and extended WSE baseline results for 1970–2015 for each tributary are described and discussed in the sections that follow.

21.7 Stanislaus River Diversions and Carryover Storage

21.7.1 Historical

Figure 21-4 shows the Stanislaus River runoff and average runoff along with historical diversions and end-of-September reservoir carryover storage drawdown for WY 1970–2015. Drought years are identified as years with substantial diversion deficits (e.g., <80 percent full diversions). The historical diversions from WY 1970–2015 were generally above 500 TAF, with a maximum of about 600 TAF in a few years. The full contract diversions were increased from 600 TAF to 755 TAF in 1997 (as a result of SEWD and CSJWCD receiving water). The historical diversions were often less than the contract maximum, but historical records do not provide an explanation for this difference, which could include water transfers between users. The historical reservoir carryover storage drawdown was generally effective in minimizing diversion deficits in most years. The historical reservoir operations in 2012–2015 show reduced diversions to about 515 TAF in 2014, and reduced carryover storages to about 520 TAF in 2014. The low Stanislaus River runoff of 329 TAF in 2015 and reduced carryover storage in 2014 resulted in low diversions (425 TAF) and low carryover storage (267 TAF) in 2015.

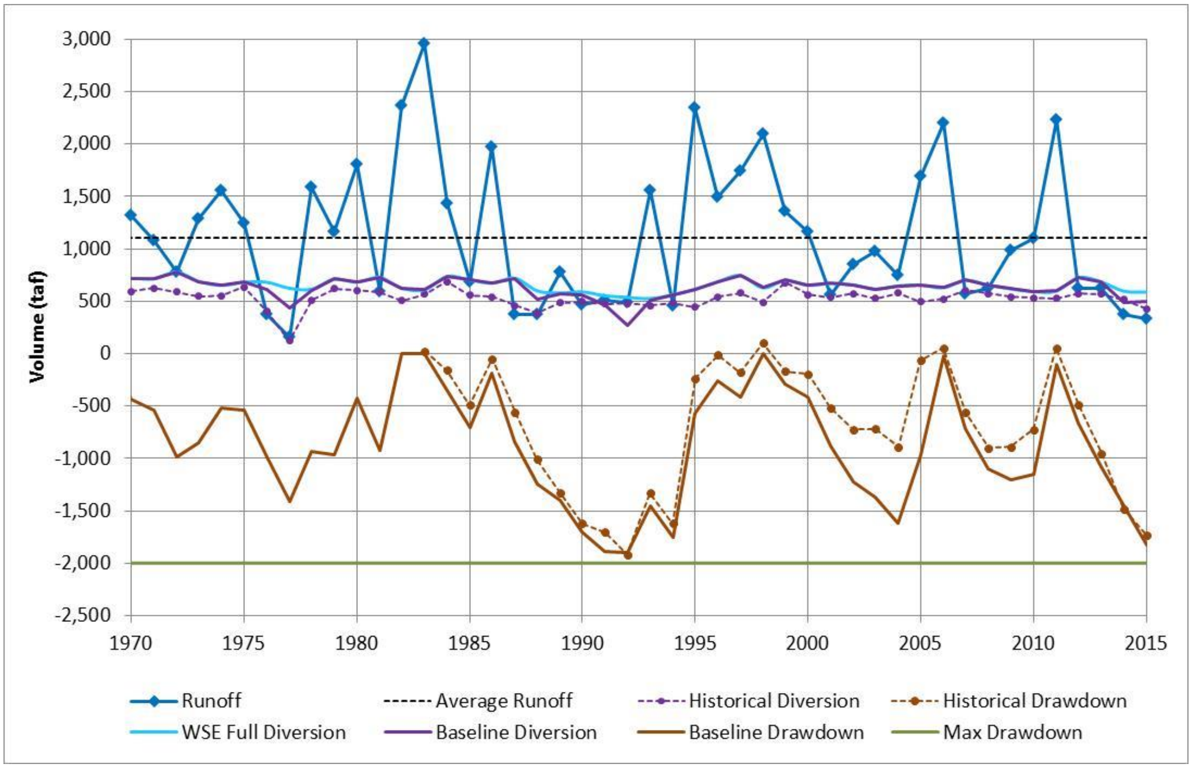

Figure 21-4. Stanislaus River Runoff with Historical and WSE Baseline Diversions, Diversion Deficits and Carryover Storage Drawdowns for WY 1970–2015

21.7.2 WSE Baseline

The Stanislaus River WSE-modeled full diversions averaged 651 TAF, and annual diversions were 100 percent of full diversions in 70 percent of the years (Table 21-3). The annual WSE baseline diversions were less than 92 percent of full diversions in 10 percent of the years, were less than 80 percent of full diversions in less than 5 percent of the years. The minimum Stanislaus River WSE baseline diversions (in 1992) were 50 percent of average full diversions.

The WSE model baseline results are also shown in Figure 21-4. The WSE baseline results were higher than the historical diversions and lower than the historical carryover storage patterns. The WSE baseline diversions were often higher than historical diversions because the full contract diversions of 755 TAF were included in the WSE baseline. The WSE baseline required release flows (e.g., flows required by the RPA) were considerably higher than the historical release flows. The WSE baseline carryover storage pattern was almost identical to the historical carryover storage for 1987–1994, but the WSE carryover storage was much less than historical carryover storage for 2000–2005, was slightly less than historical in 2007–2010, and was very similar for 2012–2015. The differences in the carryover storage can be caused by differences in diversions, differences in the required releases, or differences in the flood control releases; the differences in New Melones Reservoir storages appear to be caused by slightly higher WSE diversions during these recent dry year periods. Generally, the WSE baseline provides a very accurate calculation of drought conditions for the Stanislaus River, caused by the combination of dry year periods, with higher full water supply diversions and higher required flow releases.

Historical operations and the extended WSE baseline results demonstrate that New Melones Reservoir storage can sustain full water supply diversions through several dry years. The severity of drought years for the Stanislaus River can be determined by the distribution of diversion deficits as a percentage of full diversions. For the extended WSE baseline diversions in 1922–2015, there were 10 years (11 percent of years) with a deficit of >65 (10 percent of average full diversions), and 3 years (3 percent of years) with a deficit of >130 TAF (20 percent of average full diversions). If greater than a 20 percent water supply diversion deficit is used to identify drought years, the Stanislaus River extended WSE baseline diversions were reduced to less than 80 percent of full diversions in about 3 percent of the years.

21.7.3 Tuolumne River Diversions and Carryover Storage

21.7.4 Historical

Figure 21-5 shows the Tuolumne River runoff and average runoff along with historical diversions and carryover storages for WY 1970–2015. Drought years are identified as years with substantial diversion deficits (e.g., <80 percent full diversions). The historical diversions from La Grange Dam for MID/TID from WY 1970–1995 were generally about 1,000 TAF, with a maximum of 1,100 TAF in a few years. A full diversion target of 1,000 TAF for the MID/TID canals was assumed for the historical analysis.

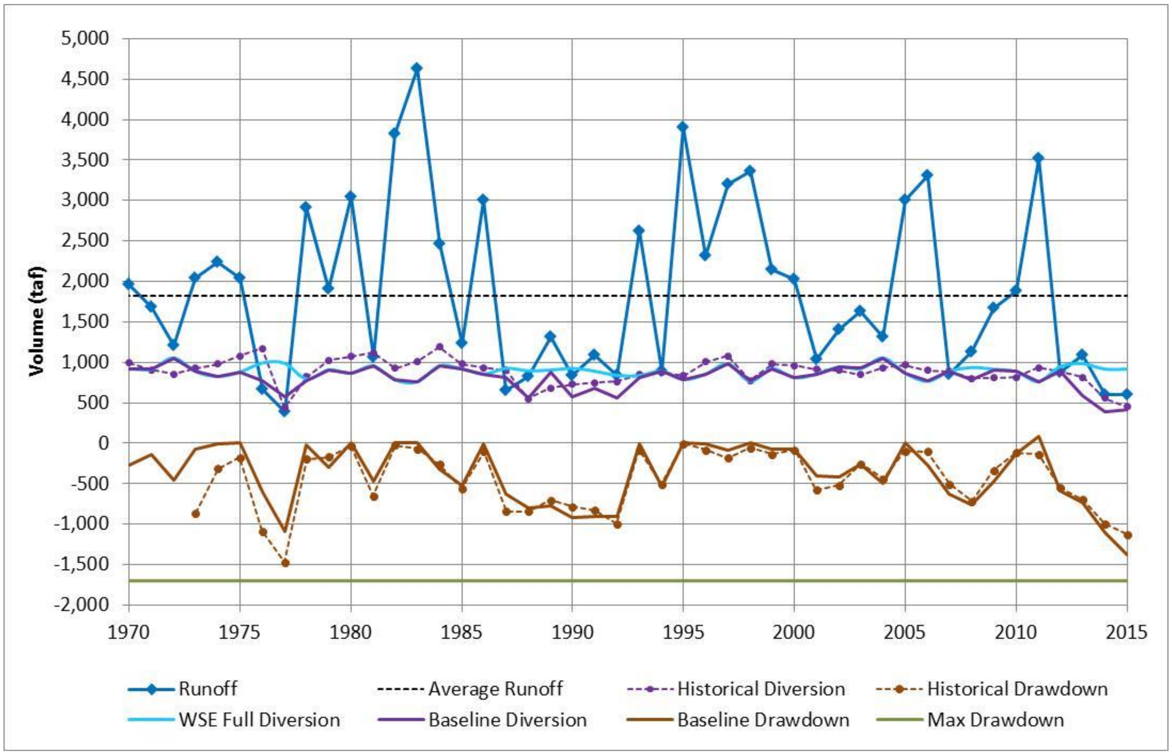

Figure 21-5. Tuolumne River Runoff with Historical and WSE Baseline Diversions, Diversion Deficits and Carryover Storage Drawdowns for WY 1970–2015

The historical diversions were less than 1,000 TAF in 1977 and 1978, in 1988–1994, and in 1998. The historical New Don Pedro Reservoir carryover storage was reduced in most of the dry years. However, because the CCSF has a large water bank in New Don Pedro Reservoir, and because MID/TID also maintain a moderate carryover storage, the carryover storage was only rarely less than 1,000 TAF (carryover storage deficit of more than 750 TAF). The minimum historical carryover storage was 250 TAF in 1977, and was 750 TAF in 1992.

The historical reservoir operations during 2012–2015 showed reduced diversions to about 560 TAF in 2014 and reduced carryover storage to 780 TAF in 2014. The low Tuolumne River runoff of 602 TAF in 2015 and reduced carryover storage in 2014 resulted in low diversions (450 TAF) and low carryover storage (644 TAF) in 2015.

21.7.5 WSE Baseline

The Tuolumne River WSE model full diversions averaged 901 TAF, and annual diversions were 100 percent of full diversions in 60 percent of the years (Table 21-3). The annual WSE baseline diversions were less than 92 percent of full diversions in 20 percent of the years, were less than 67 percent of full diversions in 10 percent of the years, and the minimum diversions were 43 percent of full diversions in 2014 (Table 21-3).

The extended WSE baseline results are also shown in Figure 21-5. The WSE model showed average full diversions were 901 TAF, which generally matched the historical MID/TID diversions for 1970–2015. The WSE baseline diversions averaged 840 TAF (93 percent of full diversions) with diversion deficits in most of the same years as historical diversion deficits. The WSE baseline carryover storage pattern was nearly identical to the historical New Don Pedro Reservoir storage; the WSE diversions and carryover storage for the Tuolumne River was very close to the historical operations. The general agreement between the historical operations and the WSE model results indicate that the new Don Pedro reservoir operations have not changed substantially during the 1970–2015 period. Although the historical and WSE model diversions fluctuated somewhat differently, the average diversions were similar (882 TAF for historical and 813 TAF for WSE model results) and the required flows were also similar, so the reservoir drawdown in dry year periods was similar. Generally, the WSE baseline provides a very accurate calculation of drought conditions for the Tuolumne River.

Historical operations and the extended WSE baseline results demonstrate that New Don Pedro reservoir storage can sustain full water supply diversions through several dry years. The severity of drought years for the Tuolumne River can be determined by the water supply diversion deficits as a percentage of full diversions. For the extended WSE baseline diversions in 1922–2015, there were 19 years (20 percent of years) with a deficit of >90 (10 percent of average full diversions), and 13 years (14 percent of years) with a deficit of >180 TAF (20 percent of average full diversions). If greater than a 20 percent water supply diversion deficit is used to identify drought years, the Tuolumne River extended WSE baseline diversions were reduced to less than 80 percent of full diversions in about 14 percent of the years (1 or 2 out of 10).

21.8 Merced River Diversions and Carryover Storage

21.8.1 Historical

Figure 21-6 shows the Merced River runoff and average runoff along with historical diversions and carryover storages for WY 1970–2015. Drought years are identified as years with substantial diversion deficits (e.g., <80 percent full diversions). The historical diversions from the Merced River for the Merced ID canals were about 550 TAF; this was assumed as the full diversion for the historical analysis. The historical diversion were less than 500 TAF in 1977, 1988–1993, 2008, and in 2012–2015. The historical Lake McClure carryover storage (maximum of 850 TAF) was reduced in most of the dry years. The historical carryover storage was 100 TAF in 1977, was about 100–200 TAF in 1988–1992, was reduced to 120 TAF in 2014, and was 87 TAF in 2015.

The historical reservoir operations during 2012–2015 showed reduced diversions of 210 TAF and reduced carryover storage of 122 TAF in 2014. The low Merced River runoff and reduced carryover storage in 2014 resulted in very low diversions (20 TAF) and very low carryover storage (87 TAF) in 2015.

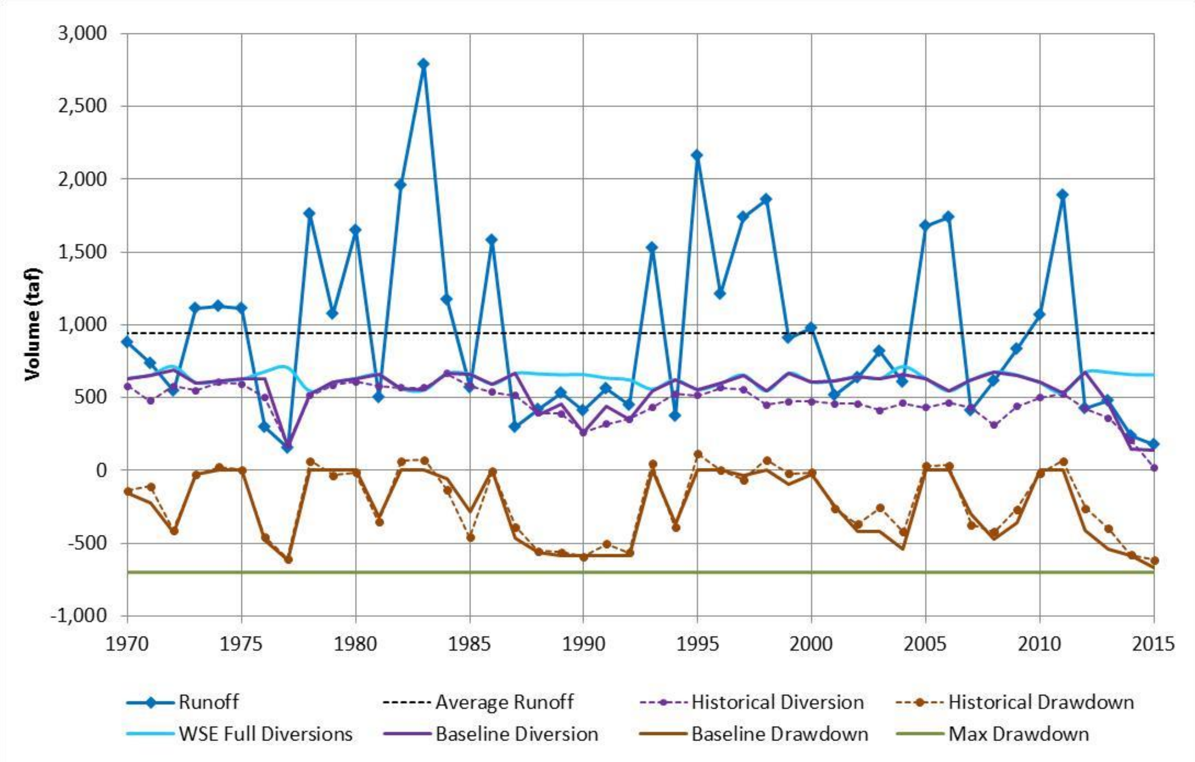

Figure 21-6. Merced River Runoff with Historical and WSE Baseline Diversions, Diversion Deficits and Carryover Storage Drawdowns for WY 1970–2015

21.8.2 WSE Baseline

The WSE model showed Merced River full diversions averaged 632 TAF, and annual diversions were 100 percent of full diversions in 60 percent of the years (Table 21-3). The annual WSE baseline diversions were less than 92 percent of full diversions in 20 percent of the years, were less than 63 percent of full diversions in 10 percent of the years, and the minimum Merced River WSE baseline diversions of 137 TAF (in 2015) were 21 percent of full diversions.

The extended WSE baseline results are also shown in Figure 21-6. The WSE model showed average full diversions were 632 TAF (including the riparian diversions of about 50 TAF) and the WSE baseline diversions averaged 574 TAF (91 percent of full diversions). The WSE baseline diversions were higher than the historical diversions, with diversion deficits in most of the same years. The WSE baseline carryover storage pattern was also nearly identical to the historical carryover storages. Overall the extended WSE baseline provides an accurate match with the historical Lake McClure operations for 1970–2015.

Historical operations and the extended WSE baseline results demonstrate that Lake McClure storage can sustain full water supply diversions through only a few dry years. The severity of drought years for the Merced River can be determined by the diversion deficits as a percentage of full diversions. For the WSE baseline diversions in 1922–2015, there were 18 years (19 percent of years) with a deficit of >63 (10 percent of average full diversions), and 14 years (15 percent of years) with a deficit of >126 TAF (20 percent of average full diversions). If greater than a 20 percent water supply diversion deficit is used to identify drought years, the Merced River extended WSE baseline diversions were less than 80 percent of full diversions in about 15 percent of the years (1 or 2 out of 10).

21.9 LSJR Alternatives and Water Supply Operations

The monthly WSE model used for this recirculated substitute environmental document (SED) evaluation of the LSJR flow objective alternatives calculated the reservoir operations and diversions for the 1922–2003 monthly runoff (or reservoir inflow). The extended WSE model matched the recent historical operations for 2004–2015 very well, as described in the previous section. The extended WSE model-calculated annual results for water supply diversions, required river releases, flood-control releases, reservoir evaporation, and carryover storage for each LSJR alternative are summarized and compared with the baseline results for each tributary.

The WSE model results indicate that implementing the LSJR alternatives would result in more years with drought conditions (i.e., reduced water availability and thus reduced water supply diversions). Increasing the February–June flows under the LSJR alternatives would reduce the reservoir carryover storage in dry years and would reduce the water supply diversions in dry year periods. Although some years with high runoff (and flood-control spills) would still provide full diversions and maximum carryover storage, most years would have reduced storage and/or reduced diversions. This section summarizes the extended WSE baseline and LSJR alternative annual results, showing and describing the likely release flows under each LSJR alternative and corresponding changes in carryover storage and water supply diversions for each tributary. The increased drought years and increased diversion deficits are summarized as the cumulative distribution of water supply diversions for each alternative (Tables 21-7a, 21-b, 21-c, 21-d, and 21-e) for each of the tributaries.

21.9.1 Stanislaus River Operations

Figure 21-7a shows the Stanislaus River annual runoff and extended WSE modeled annual results for the baseline flow requirements[2] and the baseline flows at Ripon that includes reservoir spills in a few years, for 1922–2015. The baseline release flows are a relatively large fraction of the runoff because the baseline required flows include the RPA flow schedules. The WSE baseline required flows averaged 484 TAF (44 percent of runoff); the flows at Goodwin (with spills) averaged 437 TAF (40 percent of runoff); and the flows at Ripon, with about 100 TAF (9 percent or runoff) of local inflows, averaged 536 TAF (48 percent of runoff). The Stanislaus River baseline flows were substantially higher than the required flows (because of reservoir spills) in a few years. The flow requirements were about 500 TAF/y (range of 250 TAF/y to 750 TAF/y) and the release flows were greater than 1,000 TAF in only 5 years (about 1 out of 20 years). The WSE baseline New Melones reservoir spills averaged 52 TAF (5 percent of inflow); spills were infrequent because of the large carryover storage capacity of New Melones Reservoir (180 percent of average runoff).

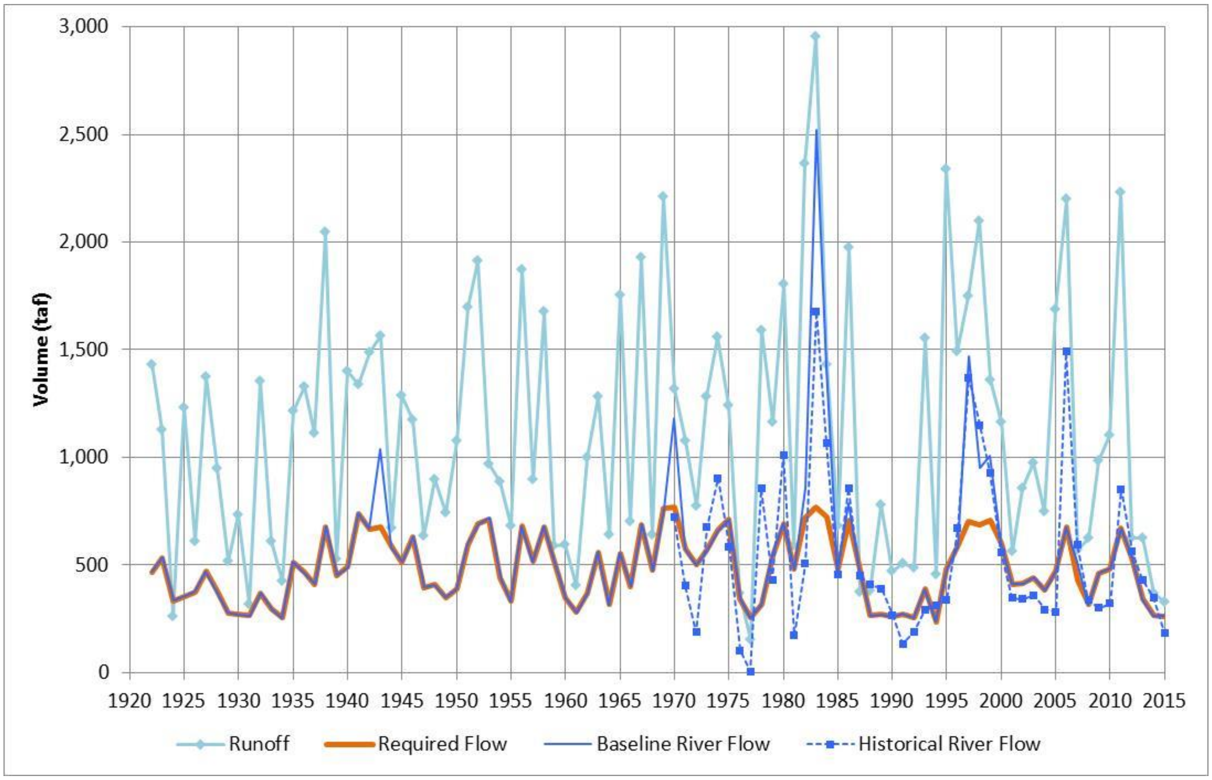

Figure 21-7a. WSE Baseline Required Flows and Release Flows at Ripon Compared with Stanislaus River Runoff and Recent Historical Flows

Figure 21-7b shows the extended WSE-modeled annual results for the baseline and flow objective alternatives release flows for the Stanislaus River at Ripon for 1922–2015. The existing flow requirements are specified at Goodwin, while the LSJR flow objectives were specified in the WSE model at Ripon, where the flows included the local inflow of about 100 TAF/y. LSJR Alternative 2

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[2] Note the term flow requirements or required flows is used in this section and on several figures to define those flows that are either required under previous or existing agreements (e.g., flow requirements for VAMP) or would be required under the different LSJR alternatives (e.g., LSJR Alternative 3 would have a flow requirement of 40 percent unimpaired flow).

required flows averaged 482 TAF (44 percent of runoff), and release flows (including a few years with reservoir spills) averaged 444 TAF (40 percent of runoff) at Goodwin and 543 TAF (49 percent of runoff) at Ripon. LSJR Alternative 3 required flows averaged 576 TAF (52 percent of runoff) and release flows averaged 512 TAF (46 percent of runoff) at Goodwin and 610 TAF (55 percent of runoff) at Ripon. LSJR Alternative 4 required flows averaged 720 TAF (65 percent of runoff) and release flows averaged 640 TAF (58 percent of runoff) at Goodwin and 739 TAF (67 percent of runoff) at Ripon. All of the LSJR alternatives increased the fraction of runoff released for required flows, but LSJR Alternative 2 was similar to the baseline flows, because the baseline required flows (e.g., RPA schedules) were generally about 20 percent of the February–June runoff. LSJR Alternatives 3 and 4 increased the annual required flows and released flows in almost every year for the Stanislaus River because the New Melones Reservoir storage is large and reservoir spills occurred in only a few years under baseline.

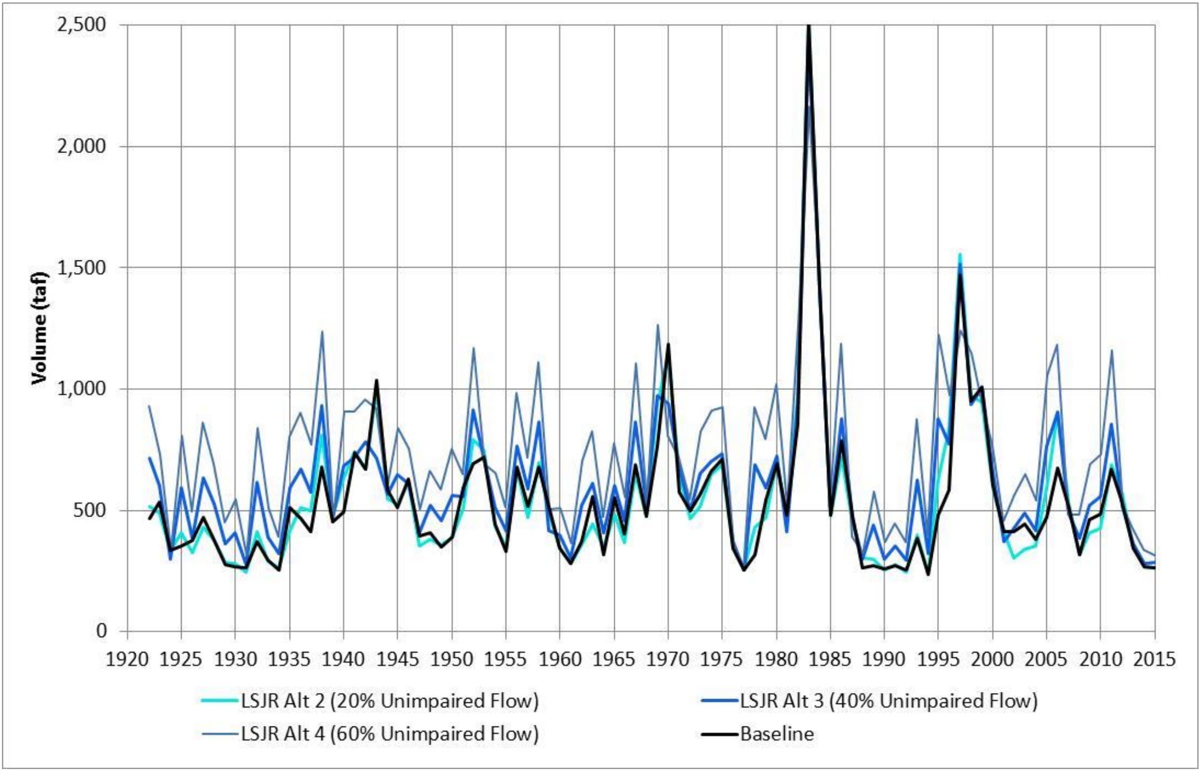

Figure 21-7b. WSE Baseline and LSJR Flow Objective Alternative Results for Stanislaus River Annual Flows at Ripon (TAF) for 1922–2003

Figure 21-7c shows the WSE-modeled annual results for New Melones carryover storage for the baseline and flow objective alternatives for 1922–2015. The baseline carryover storage was rarely full (2,000 TAF maximum) because the reservoir storage is almost twice the average runoff and several dry years are generally needed to reduce the storage, while several wet years are generally needed to refill the storage. The WSE baseline carryover storage was nearly full in only 6 years (1969, 1982, 1983, 1998, 2006, and 2011). The baseline carryover storage was low (<750 TAF) at the end of each major dry year period (e.g., 1929–1936, 1949–1950, 1961–1964, 1977, 1988–1994, 2002–2004, and 2014–2015). The New Melones Reservoir storage was large enough to provide nearly full diversions in many dry years, even with the relatively high required flows (e.g., RPA schedules). The WSE model showed carryover storages with LSJR alternatives were sometimes lower than the baseline storages, but the WSE-modeled carryover storages for the LSJR alternatives remained above 700 TAF[3]. This reduced the water supply diversions in years when the baseline carryover storage was less than 750 TAF. LSJR Alternatives 2 and 3 had similar carryover storage patterns, but LSJR Alternative 4 caused the carryover storage to be much less when compared to LSJR Alternatives 2 and 3 in several years (e.g., 1939–1946, 1952–1953, and 1969).

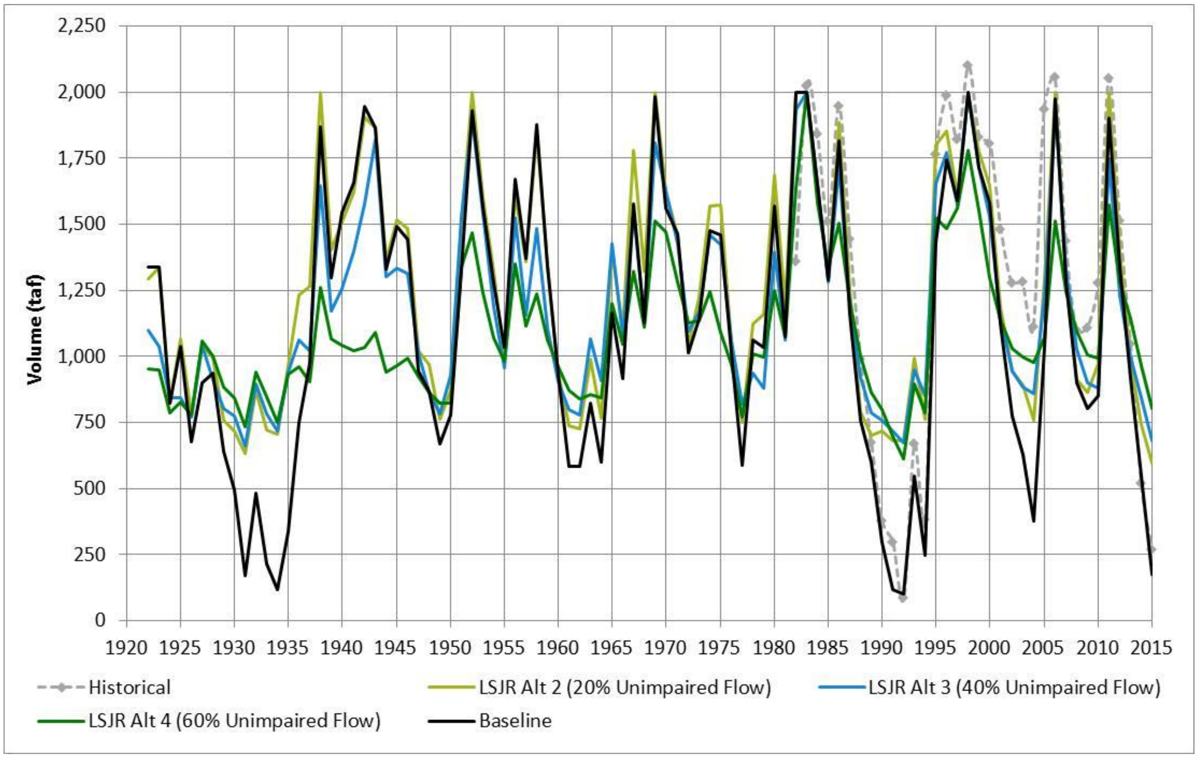

Figure 21-7c. WSE Baseline and LSJR Flow Objective Alternative Results for New Melones Carryover Storages for 1922–2015

Figure 21-7d shows the extended WSE-modeled annual results for Stanislaus River water supply diversions for the baseline and flow objective alternatives for 1922–2015. The baseline diversions fluctuated with the WSE-model full diversions (full water supply demands), generally between 550 TAF and 750 TAF. Baseline diversions were reduced in the major dry year periods (e.g., 1929–1936, 1976-1977, 1988–1994, 2002–2005 and 2013–2015). The average baseline Stanislaus River diversions were 635 TAF (57 percent of runoff). Under the LSJR alternatives, reduced diversions were largely the result of the increased flow requirements and the increased minimum carryover storage between the baseline and LSJR alternatives. The average annual diversion under LSJR Alternative 2 was reduced to 619 TAF (56 percent of runoff). The average annual diversion for LSJR Alternative 3 was reduced to 553 TAF (50 percent of runoff), and the average annual diversion for LSJR Alternative 4 was reduced to 426 TAF (39 percent of runoff). Whereas the baseline diversions were reduced only after several dry years once the carryover storage was reduced (to about 250 TAF), the increased minimum carryover storage (750 TAF) and the increased flow objectives reduced the diversions in more years. The increased carryover storage and increased required flows under the LSJR alternatives reduced the diversions to a smaller fraction of the average runoff (57

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[3] This was because the WSE model included an assumption that the carryover storage would not be reduced below 750 TAF.

percent of runoff for the baseline, 56 percent of runoff for LSJR Alternative 2, 50 percent of runoff for LSJR Alternative 3, and 39 percent of runoff for LSJR Alternative 4).

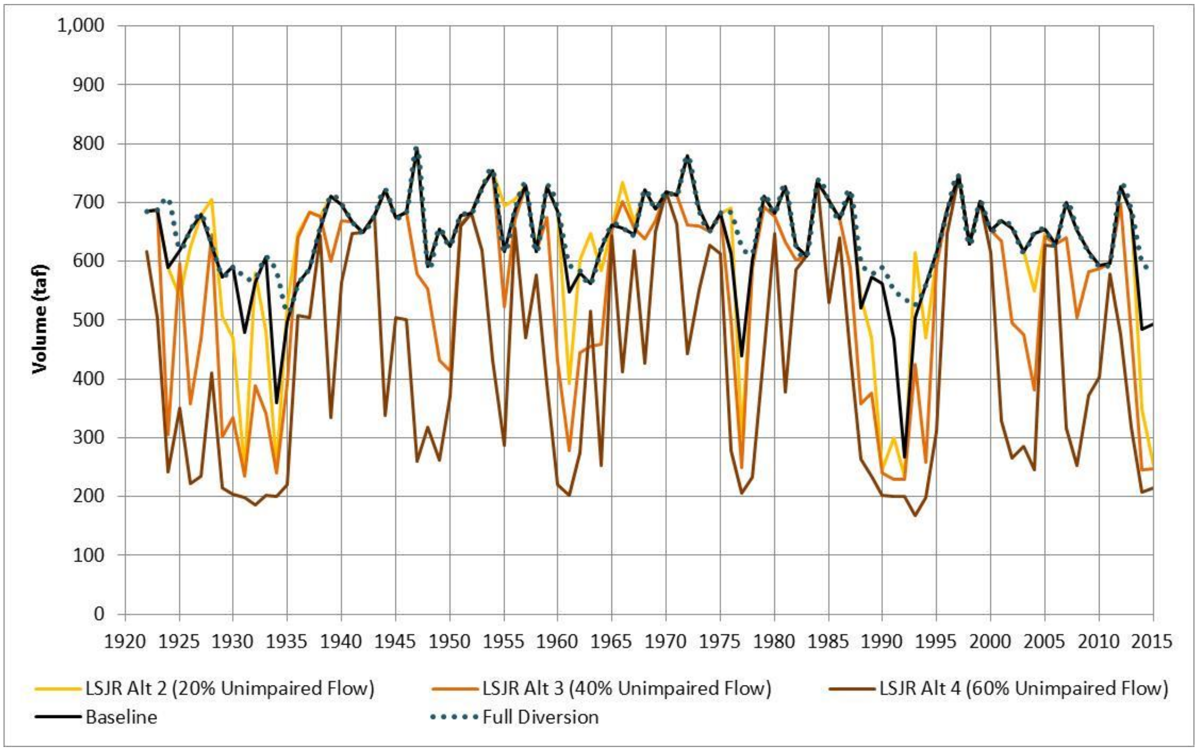

Figure 21-7d. WSE Baseline and LSJR Flow Objective Alternative Results for Stanislaus River Water Supply Diversions for 1922–2015

Table 21-4a gives a comparison of the cumulative distribution of the extended WSE model Stanislaus River water supply diversions for the LSJR alternatives for 1922–2015. There are many years with higher-than-average runoff that allowed full Stanislaus River water supply diversions under baseline conditions, even with the relatively high baseline required flows (44 percent of average runoff). The large storage capacity of New Melones Reservoir allowed full diversions in several dry year periods; reduced water supply diversions were calculated in about 10 percent of the years and the average annual diversion was 635 TAF for the WSE baseline. The LSJR Alternative 2 diversions were reduced in about 20 percent of the years; the increased minimum carryover storage requirement caused diversion deficits earlier in each dry year period, but the average annual diversion for LSJR Alternative 2 was only slightly reduced (619 TAF). The LSJR Alternative 3 diversions were reduced in about 50 percent of the years. The increased minimum carryover storage requirement shifted some of the diversion deficits, and the higher required flows reduced the diversions substantially (more than 20 percent of full diversions) in about 10 percent of the years. The average annual diversion for LSJR Alternative 3 was reduced by 12 percent of the average full diversions to 553 TAF. The LSJR Alternative 4 diversions were reduced in about 80 percent of the years. The increased minimum carryover storage requirement shifted some of the diversion deficits, and the higher required flows reduced the diversions substantially (more than 20 percent of full diversions) in about 65 percent of the years. The average annual diversion for LSJR Alternative 4 was reduced by 30 percent of the average full diversion to 426 TAF. The largest reductions in diversions for the LSJR alternatives occurred in drought years, when the baseline diversions were already reduced.

Table 21-4a. Cumulative Distributions of WSE Model Stanislaus River Diversions for LSJR Alternatives for 1922–2015

Average Runoff (TAF)	1,107
Average Full Diversion (TAF)	651

Percentile	Stanislaus Baseline Diversion (TAF)	% Full Diversion	Stanislaus LSJR Alt 2 Diversion (TAF)	% Full Diversion	Stanislaus LSJR Alt 3 Diversion (TAF)	% Full Diversion	Stanislaus LSJR Alt 4 Diversion (TAF)	% Full Diversion
Max	792	100	792	100	753	100	745	100
90	724	100	726	100	701	100	650	99
80	703	100	705	100	681	100	627	95
70	685	100	688	100	669	100	579	90
60	676	100	680	100	648	98	503	73
50	656	100	661	100	622	96	411	60
40	627	100	647	100	588	85	330	49
30	615	100	616	100	477	76	273	44
20	582	99	582	95	390	66	233	37
10	549	92	469	79	285	46	203	34
Min	268	50	235	43	230	40	167	32
Average	635	98	619	95	553	85	426	65
Average Deficit (TAF)		16		32		98		225

Figure 21-7e shows the overall effects of the extended WSE baseline and LSJR alternatives on the Stanislaus River diversion deficits. This graph illustrates the basic concept that reservoir operations are a three-way balance between the runoff and: (1) required release flows, (2) full water supply diversions, and (3) carryover storage. The sum of the annual LSJR alternatives release flow requirements (TAF) and full diversions (TAF) are plotted as a function of the runoff (TAF). The sum of the average full water supply diversions and the required flows represents the total water demands for each year. The WSE model-calculated diversion deficits are also plotted as a function of runoff. The sum of the baseline flow requirements and full diversions were generally higher than runoff, until the runoff was greater than 1,000 TAF. When the runoff was less than the average runoff, full water supply diversions required carryover storages to be reduced to supplement the runoff. The baseline diversion deficits generally increased with lower runoff, and there were some diversion deficits when runoff was less than about 1,500 TAF. The LSJR alternatives increased the water needed for required release flows and full water supply diversions, and generally resulted in larger diversion deficits. The sum of the full diversions and the required flows for LSJR Alternative 3 were generally higher than runoff until runoff was greater than 1,500 TAF. The sum of the full diversions and the required flows for LSJR Alternative 4 were generally higher than runoff until runoff was greater than 1,750 TAF.

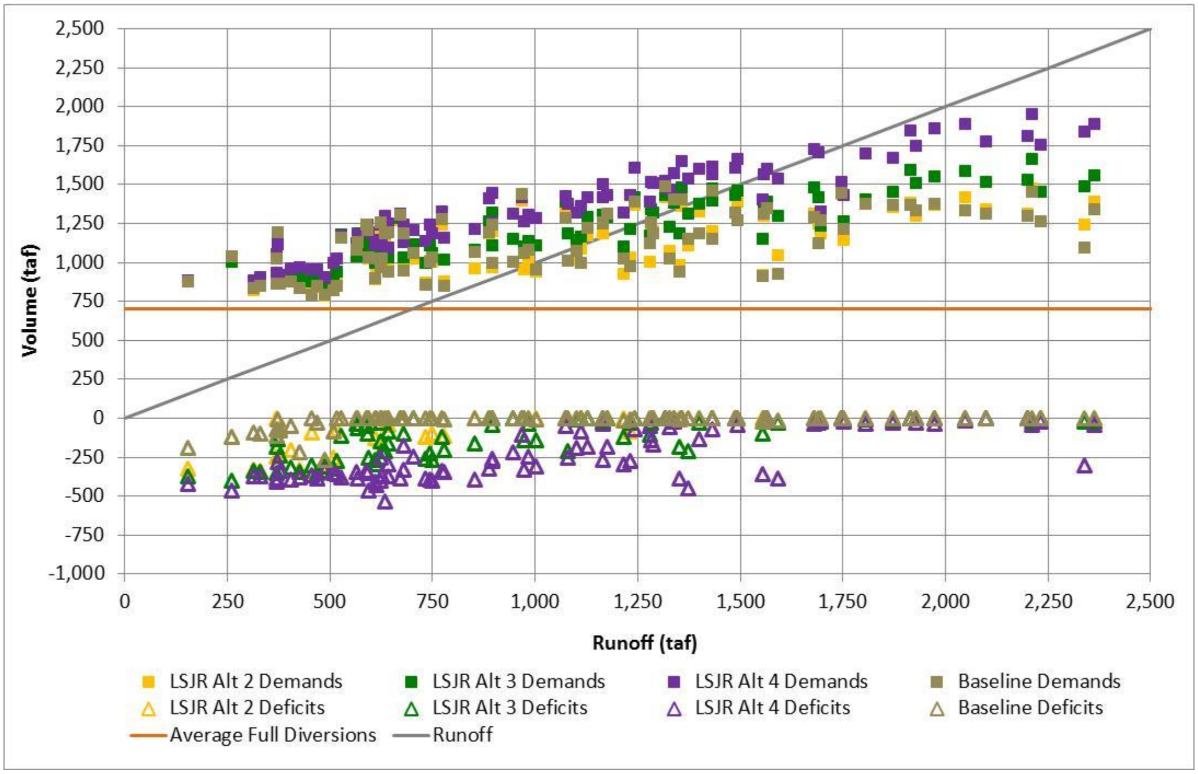

Figure 21-7e. Relationships between Stanislaus River Runoff, Sum of Alternative Flow Requirements and Full Water Supply Diversions, and Diversion Deficits for 1922–2015

21.9.2 Tuolumne River Operations

Figure 21-8a shows the Tuolumne River annual runoff and extended WSE-modeled annual results for the baseline required flows at La Grange and the baseline flows at Modesto that included reservoir spills in about half of the years (58 out of 94), for 1922–2015. The WSE baseline required flows averaged 443 TAF (28 percent of inflow), the release flows at La Grange (with spills) averaged 683 TAF (43 percent of inflow) and the total flows at Modesto, with about 215 TAF (14 percent of inflow) of local inflows, averaged 897 TAF (57 percent of inflow). The Tuolumne River baseline flows are substantially higher than the required flows (because of reservoir spills) in many years. The baseline required flows were about 500 TAF/y (range of 200 TAF/y to 800 TAF/y) and the release flows were greater than 1,000 TAF in about 38 years (4 out of 10 years). The WSE baseline New Don Pedro Reservoir spills averaged 454 TAF (29 percent of inflow).

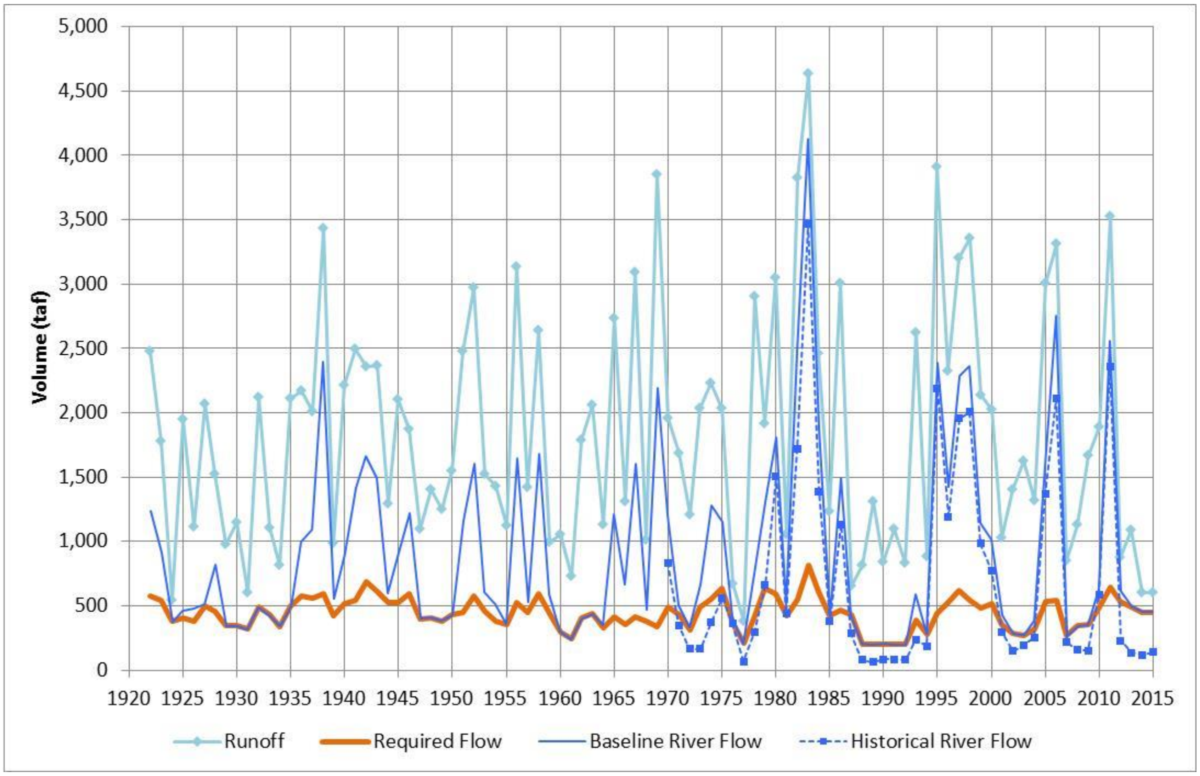

Figure 21-8a. WSE Baseline Required Flows and Release Flows at Modesto Compared with Tuolumne River Runoff and Recent Historical Flows

Figure 21-8b shows the extended WSE-modeled annual results for the baseline and LSJR alternative release flows at Modesto compared to the annual New Don Pedro Reservoir inflow (i.e., runoff minus 250 TAF) for the Tuolumne River for 1922-2015. The baseline minimum flows are required at La Grange, while the required flows for the LSJR alternatives were specified in the WSE model at Modesto, where the flows included the local inflow of 215 TAF/y. The LSJR Alternative 2 required flows averaged 525 TAF (33 percent of inflow) and the LSJR Alternative 2 release flows (including reservoir spills) averaged 702 TAF (45 percent of inflow) at La Grange and 916 TAF (58 percent of inflow) at Modesto. Spills were reduced to an average of 392 TAF (25 percent of inflow). The LSJR Alternative 3 required flows averaged 774 TAF (49 percent of inflow) and the LSJR Alternative 3 release flows averaged 802 TAF (51 percent of inflow) at La Grange and 1,016 TAF (64 percent of inflow) at Modesto. Spills were reduced to an average of 242 TAF (15 percent of inflow). The LSJR Alternative 4 required flows averaged 1,048 TAF (66 percent of inflow) and the LSJR Alternative 4 release flows averaged 978 TAF (62 percent of inflow) at La Grange and 1,192 TAF (76 percent of inflow) at Modesto. Spills were reduced to an average of 143 TAF (9 percent of inflow). The LSJR alternatives increased the fraction of runoff released for required flows and reduced the fraction of the reservoir inflow that was released for flood control (spills).

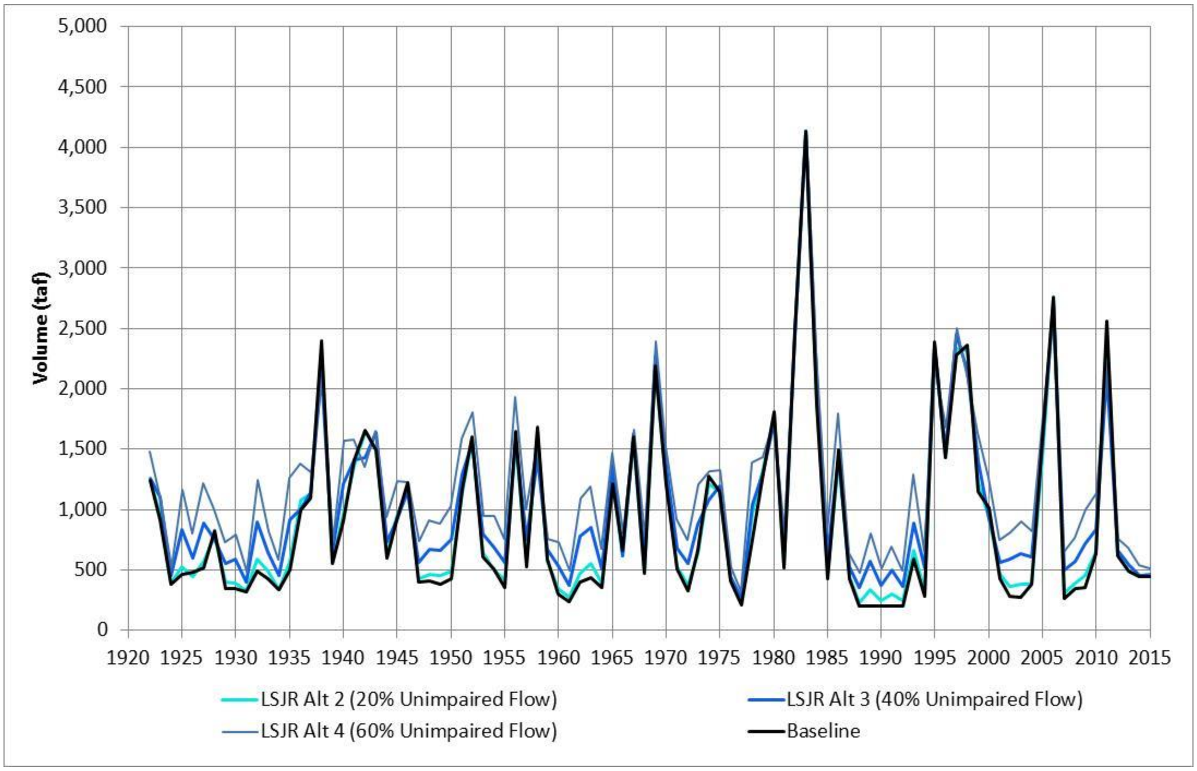

Figure 21-8b. WSE Baseline and LSJR Flow Objective Alternative Results for Tuolumne River Annual Flows at Modesto (TAF) for 1922–2015

Figure 21-8c shows the extended WSE-modeled annual results for New Don Pedro Reservoir carryover storage for the baseline and flow objective alternatives for 1922–2015. The baseline carryover storage was full (1,700 TAF maximum) in about 25 percent of the years. The baseline carryover storage was low (<1,000 TAF) at the end of each major dry year period (e.g., 1929–1934, 1947–1950, 1960–1962, 1977, 1988–1992, 2008, and 2013–2015). The New Don Pedro Reservoir storage was large enough to provide nearly full diversions in many dry years. The WSE model carryover storages with the flow objective alternatives were sometimes lower, because the higher required flows reduced the carryover storage in some years; but many other years had similar carryover storages because although the alternative flow objectives increased the required flows from February–June, the higher release flows reduced reservoir spills and so the carryover storages remained similar.

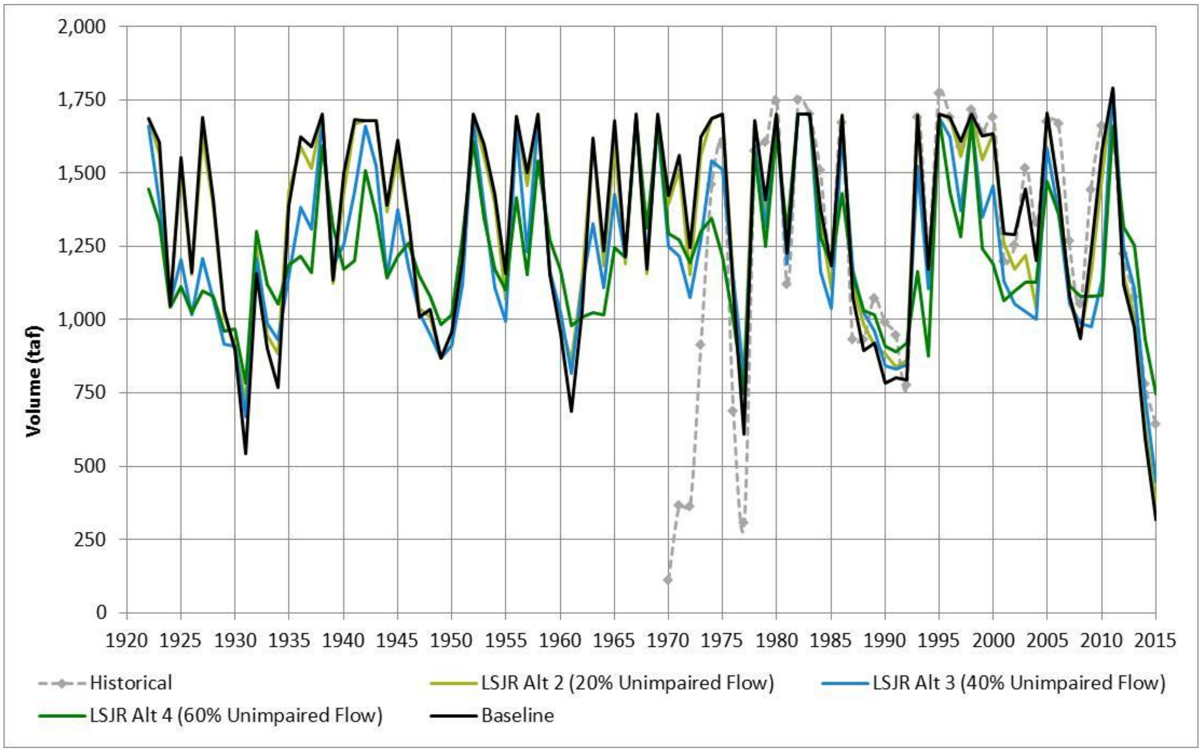

Figure 21-8c. WSE Baseline and LSJR Flow Objective Alternative Results for New Don Pedro Carryover Storages for 1922–2015

Figure 21-8d shows the extended WSE-modeled annual results for Tuolumne River water supply diversions for the baseline and LSJR alternatives for 1922–2015. The baseline diversions fluctuated with the WSE model full diversions (full water supply demands), generally between 800 TAF and 1,000 TAF. Baseline diversions were reduced to less than 800 TAF in a few years. The average baseline Tuolumne River diversions were 840 TAF (53 percent of inflow). The average annual diversion for LSJR Alternative 2 was reduced to 820 TAF (52 percent of inflow). The average annual diversion for LSJR Alternative 3 was reduced to 722 TAF (46 percent of inflow) and the average annual diversion for LSJR Alternative 4 was reduced to 545 TAF (35 percent of inflow).

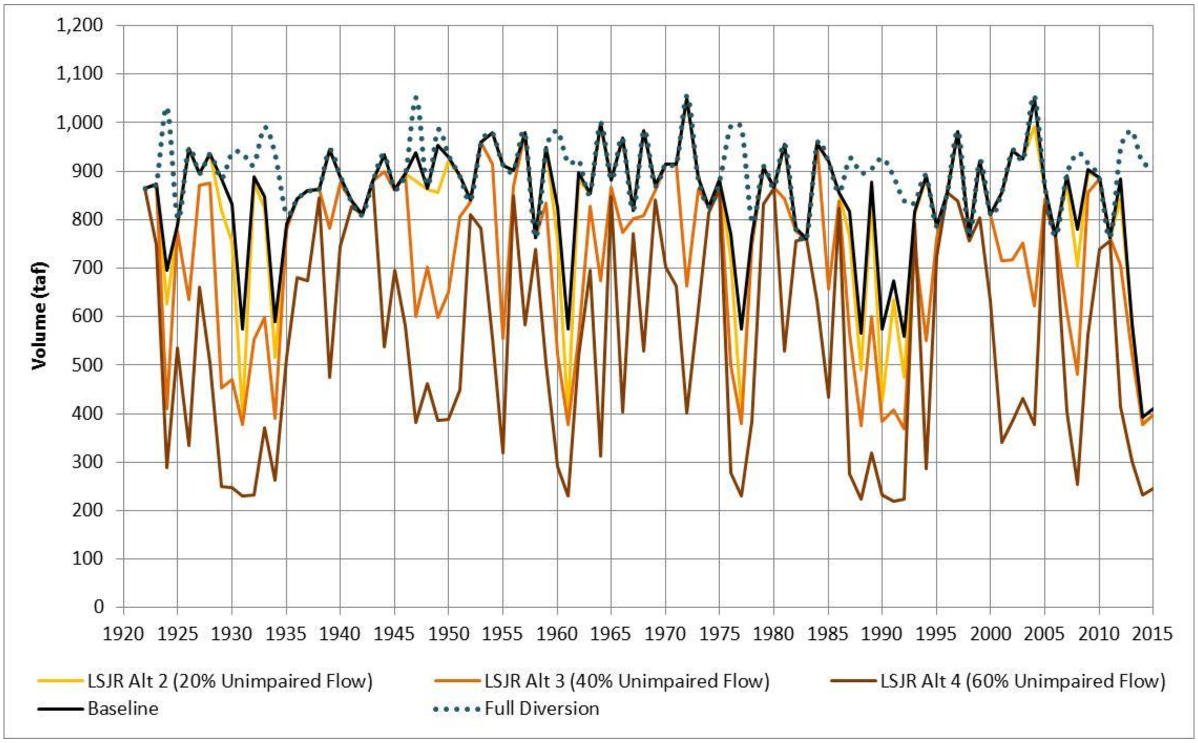

Figure 21-8d. WSE Baseline and LSJR Flow Objective Alternative Results for Tuolumne River Water Supply Diversions for 1922–2015

Table 21-4b gives a comparison of the cumulative distribution of WSE-modeled Tuolumne River water supply diversions for the LSJR alternatives for 1922–2015. There were many years (approximately half of the years) with higher than average runoff that allowed full Tuolumne River water supply diversions under baseline conditions. The large storage capacity of New Don Pedro Reservoir allowed full diversions in several dry year periods; reduced water supply diversions were calculated in about 20 percent of the years, and the average annual diversion for the baseline was 840 TAF. The LSJR Alternative 2 diversions were reduced in about 25 percent of the years; the average annual diversion for LSJR Alternative 2 was reduced slightly to 820 TAF. The LSJR Alternative 3 diversions were reduced in about 50 percent of the years; the diversions were reduced substantially (more than 20 percent of full diversions) in about 40 percent of the years. The average annual diversion for LSJR Alternative 3 was reduced to 722 TAF. The LSJR Alternative 4 diversions were reduced in about 80 percent of the years the diversions were reduced substantially (more than 20 percent of full diversions) in about 65 percent of the years; the diversions were less than half of full diversions in 45 percent of the years. The average annual diversion for LSJR Alternative 4 was reduced to 545 TAF.

Table 21-4b. Cumulative Distributions of WSE Model Tuolumne River Diversions for LSJR Alternatives for 1922–2015

Average Runoff (TAF)	1,827
Average Full Diversion (TAF)	901

Percentile	Tuolumne Baseline Diversion (TAF)	% Full Diversion	Tuolumne LSJR Alt 2 Diversion (TAF)	% Full Diversion	Tuolumne LSJR Alt 3 Diversion (TAF)	% Full Diversion	Tuolumne LSJR Alt 4 Diversion (TAF)	% Full Diversion
Max	1,050	100	1,050	100	982	100	879	100
90	957	100	957	100	898	100	836	99
80	931	100	921	100	867	100	787	96
70	901	100	895	100	857	100	740	84
60	886	100	879	100	823	97	655	74
50	869	100	862	100	774	94	532	57
40	856	100	842	100	746	82	436	49
30	824	99	810	98	647	67	384	40
20	775	92	764	85	554	60	297	31
10	614	67	595	60	408	44	245	27
Min	392	43	382	40	368	38	220	23
Average	840	93	820	91	722	80	545	61
Average Deficit (TAF)		61		81		179		356

Figure 21-8e shows the overall effects of the WSE baseline and LSJR alternatives on the Tuolumne River diversion deficits. This graph illustrates the basic concept that reservoir operations are a three-way balance between the runoff and: (1) required release flows, (2) full water supply diversions, and (3) carryover storage. The sum of the annual LSJR alternatives release flow requirements (TAF) and full diversions (TAF) are plotted as a function of the runoff (TAF). The sum of the average full water supply diversions and the required flows represents the total water demands for each year. The full diversions include the 250 TAF upstream diversions to CCSF. The WSE model calculated diversion deficits are also plotted as a function of runoff. The sum of the baseline flow requirements and full diversions were generally higher than runoff, until the runoff was greater than 1,500 TAF. When the runoff was less than the average runoff, full water supply diversions required carryover storages to be reduced to supplement the runoff. The baseline diversion deficits generally increased with lower runoff, and there were some diversion deficits when runoff was less than about 1,250 TAF. The LSJR alternatives increased the water needed for required release flows and full water supply diversions, and generally resulted in larger diversion deficits. The sum of the full diversions and the required flows for LSJR Alternative 3 were generally higher than runoff until runoff was greater than 2,000 TAF. The sum of the full diversions and the required flows for LSJR Alternative 4 were generally higher than runoff until runoff was greater than 2,500 TAF.

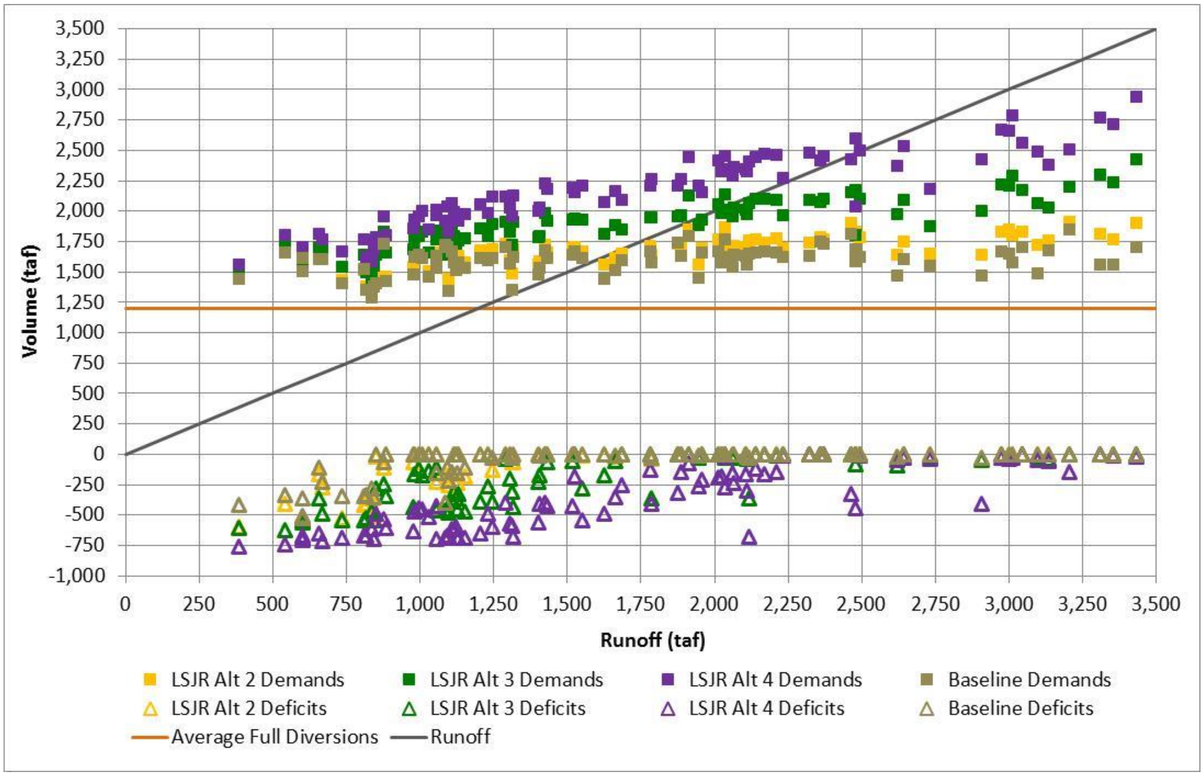

Figure 21-8e. Relationships between Tuolumne River Runoff, Sum of Alternative Flow Requirements and Full Water Supply Diversions, and Diversion Deficits for 1922–2015

21.9.3 Merced River Operations

Figure 21-9a shows the Merced River annual runoff and extended WSE-modeled annual results for the baseline required flows at the Crocker-Huffman Dam and the baseline flows at Stevinson that included reservoir spills in many years, for 1922–2015. The baseline release flows at Stevinson were a relatively small fraction of the runoff in years without reservoir spills, and a larger fraction of runoff in years with spills. The WSE baseline required flows averaged 229 TAF (24 percent of runoff); the release flows at Crocker-Huffman Dam (with spills and about 50 TAF for Cowell Agreement diversions) averaged 382 TAF (40 percent of runoff); and the total flows at Stevinson, with 118 TAF (13 percent of runoff) of local inflows minus 50 TAF for riparian diversions, averaged 450 TAF (48 percent of runoff). The Merced River baseline flows were substantially higher than the required flows (because of reservoir spills) in several years. The required flows were about 200 TAF/y (range of 100 TAF/y to 400 TAF/y) and the release flows were greater than 500 TAF in about 25 years (3 out of 10 years). The WSE baseline Lake McClure spills averaged 222 TAF (23 percent of runoff).

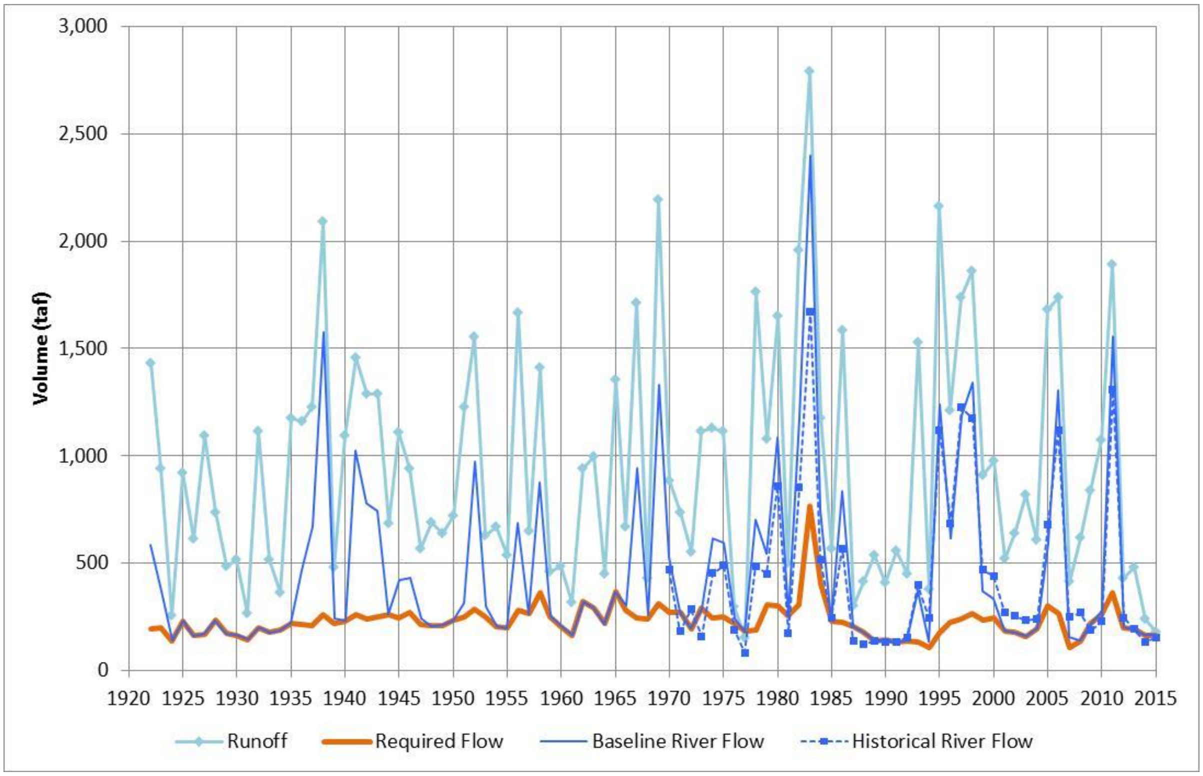

Figure 21-9a. WSE Baseline Required Flows and Release Flows at Stevinson Compared with Merced River Runoff and Recent Historical Flows

Figure 21-9b shows the extended WSE-modeled annual results for the baseline and LSJR alternatives release flows for the Merced River at Stevinson for 1922–2015. The LSJR Alternative 2 required flows averaged 288 TAF (30 percent of runoff), and the LSJR Alternative 2 release flows (including a few years with reservoir spills) averaged 414 TAF (44 percent of runoff) at Crocker-Huffman Dam and 482 TAF (51 percent of runoff) at Stevinson. The spills were reduced to 195 TAF (21 percent of runoff).The LSJR Alternative 3 required flows averaged 420 TAF (44 percent of runoff), and the LSJR Alternative 3 release flow averaged 475 TAF (50 percent of runoff) at Crocker-Huffman Dam and 543 TAF (57 percent of runoff) at Stevinson. The spills were reduced to 123 TAF (13 percent of runoff). The LSJR Alternative 4 required flows averaged 562 TAF (59 percent of runoff), and the LSJR Alternative 4 release flows averaged 561 TAF (59 percent of runoff) at Crocker-Huffman Dam and 630 TAF (67 percent of runoff) at Stevinson. The LSJR Alternative 4 spills were reduced to 68 TAF (7 percent of runoff).

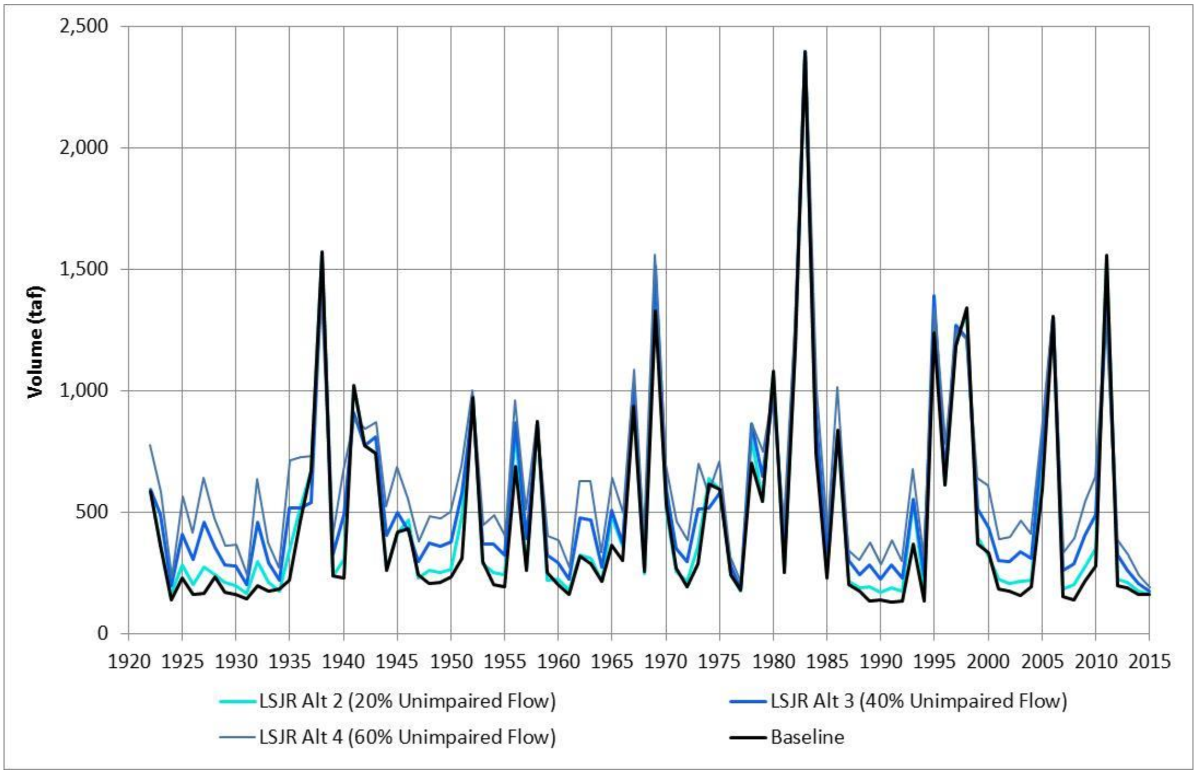

Figure 21-9b. WSE Baseline and LSJR Flow Objective Alternative Results for Merced River Annual Flows at Stevinson (TAF) for 1922–2015

Figure 21-9c shows the extended WSE-modeled annual results for Lake McClure carryover storage for the baseline and flow objective alternatives for 1922–2015. The baseline carryover storage was often full (700 TAF maximum) because the reservoir storage is less than the average runoff. The baseline carryover storage was low (<125 TAF) at the end of each major dry year period. The Lake McClure storage was large enough to provide nearly full diversions in some dry years, with reduced carryover storage, but the carryover storages for the LSJR flow objective alternatives were higher in some years, because a minimum carryover of about 250 TAF was assumed in the WSE model.

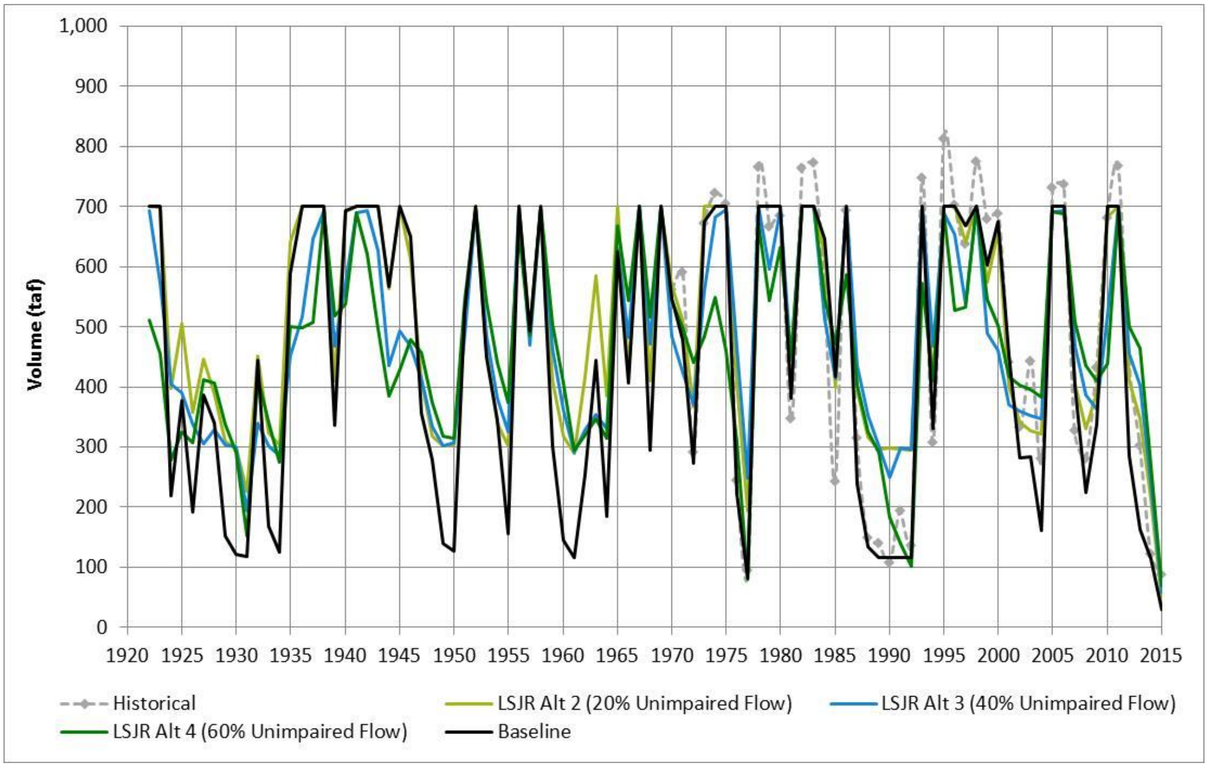

Figure 21-9c. WSE Baseline and LSJR Flow Objective Alternative Results for Lake McClure Carryover Storages for 1922–2015

Figure 21-9d shows the extended WSE-modeled annual results for Merced River water supply diversions for the baseline and LSJR flow objective alternatives for 1922–2015. The baseline diversions fluctuated with the WSE-modeled full diversions (water supply demands), generally between 550 TAF and 700 TAF. Baseline diversions were reduced in about 20 percent of the years. The average annual baseline Merced River diversion was 574 TAF (61 percent of runoff). The average annual diversion for LSJR Alternative 2 was reduced to 540 TAF (57 percent of runoff). The average annual diversion for LSJR Alternative 3 was reduced to 480 TAF (51 percent of runoff) and the average annual diversion for LSJR Alternative 4 was reduced to 395 TAF (42 percent of runoff).

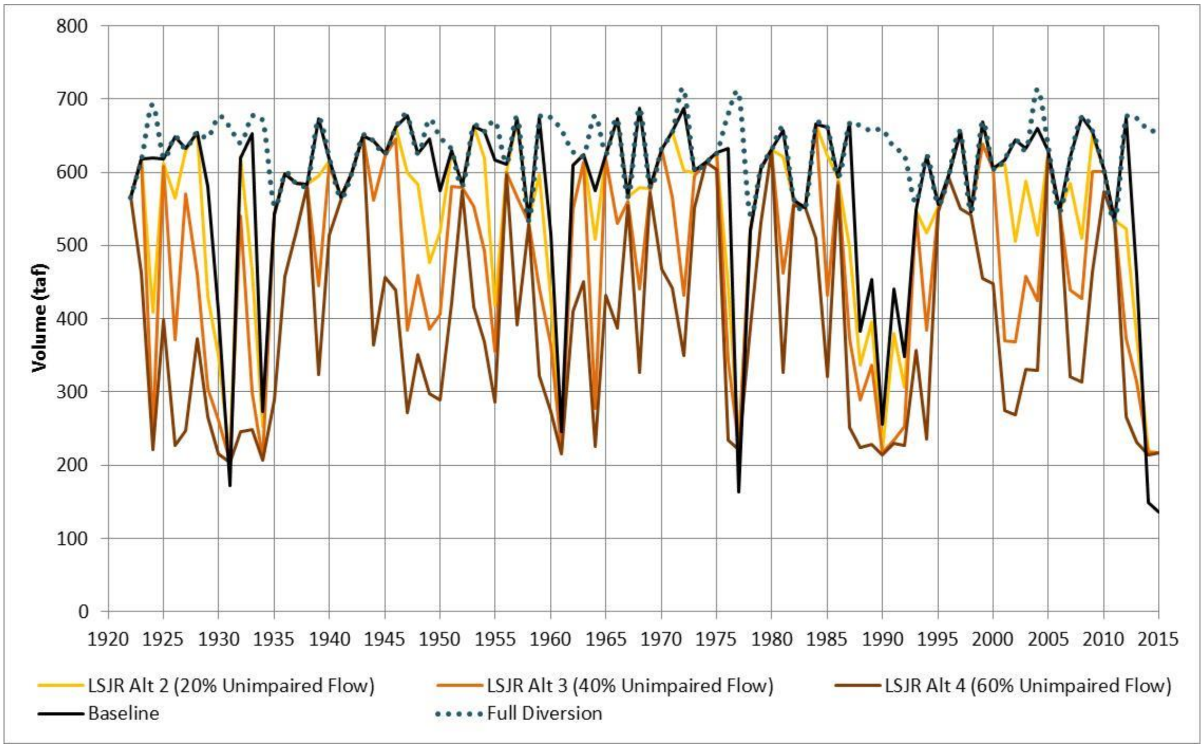

Figure 21-9d. WSE Baseline and LSJR Flow Objective Alternative Results for Merced River Water Supply Diversions for 1922–2015

Table 21-4c gives a comparison of the cumulative distribution of extended WSE model Merced River water supply diversions for the LSJR flow objective alternatives for 1922–2015. There were many years with higher-than-average runoff that allowed full Merced River water supply diversions under baseline conditions. The moderate storage capacity of Lake McClure allowed full diversions in some dry years but reduced water supply diversions were calculated in about 20 percent of the years and the average annual diversion was 574 TAF for the WSE baseline. The LSJR Alternative 2 diversions were reduced in about 40 percent of the years; the average annual diversion for LSJR Alternative 2 was reduced to 540 TAF. The higher required flows reduced the diversions substantially (more than 20 percent of full diversions) in about 25 percent of the years. The LSJR Alternative 3 diversions were reduced in about 50 percent of the years. The higher required flows reduced the diversions substantially (more than 20 percent of full diversions) in about 45 percent of the years. The average annual diversion for LSJR Alternative 3 was reduced to 480 TAF. The LSJR Alternative 4 diversions were reduced in about 75 percent of the years. The higher required flows reduced the diversions substantially (more than 20 percent of full diversions) in about 70 percent of the years; the diversions were less than half of full diversions in 40 percent of the years. The average annual diversion for LSJR Alternative 4 was reduced to 395 TAF.

Table 21-4c. Cumulative Distributions of WSE Model Merced River Diversions for LSJR Alternatives for 1922–2015

Average Runoff (TAF)	945
Average Full Diversion (TAF)	632

Percentile	Merced Baseline Diversion (TAF)	% Full Diversion	Merced LSJR Alt 2 Diversion (TAF)	% Full Diversion	Merced LSJR Alt 3 Diversion (TAF)	% Full Diversion	Merced LSJR Alt 4 Diversion (TAF)	% Full Diversion
Max	687	100	674	100	665	100	650	100
90	668	100	650	100	621	100	579	99
80	656	100	624	100	601	100	551	98
70	633	100	613	100	581	99	511	77
60	625	100	600	100	560	98	441	69
50	618	100	584	99	541	87	379	58
40	599	100	562	94	458	70	326	49
30	579	99	532	84	422	61	288	44
20	547	92	472	70	361	54	247	38
10	419	63	358	53	255	39	224	33
Min	137	21	209	32	205	31	204	31
Average	574	91	540	85	480	76	395	62
Average Deficit (TAF)		58		92		152		226

Figure 21-9e shows the overall effects of the WSE baseline and LSJR alternatives on the Merced River diversion deficits. This graph illustrates the basic concept that reservoir operations are a three-way balance between the runoff and: (1) required release flows, (2) full water supply diversions, and (3) carryover storage. The sum of the annual LSJR alternatives release flow requirements (TAF) and full diversions (TAF) are plotted as a function of the runoff (TAF). The sum of the average full water supply diversions and the required flows represents the total water demands for each year. The WSE model calculated diversion deficits are also plotted as a function of runoff. The sum of the baseline flow requirements and full diversions were generally higher than runoff, until the runoff was greater than 800 TAF. When the runoff was less than the average runoff, full water supply diversions required carryover storages to be reduced to supplement the runoff. The baseline diversion deficits generally increased with lower runoff, and there were some diversion deficits when runoff was less than about 600 TAF. The LSJR alternatives increased the water needed for required release flows and full water supply diversions, and generally resulted in larger diversion deficits. The sum of the full diversions and the required flows for LSJR Alternative 3 were generally higher than runoff until runoff was greater than 1,000 TAF. The sum of the full diversions and the required flows for LSJR Alternative 4 were generally higher than runoff until runoff was greater than 1,250 TAF.

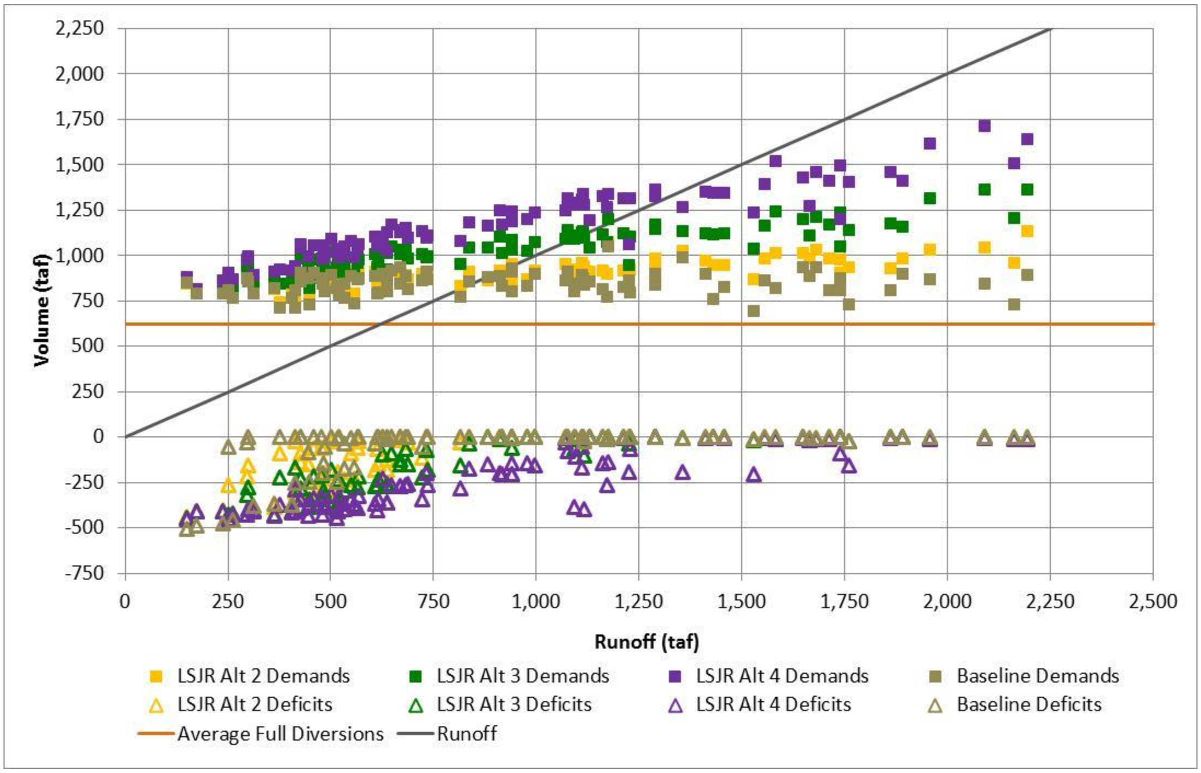

Figure 21-9e. Relationships between Merced River Runoff, Sum of Alternative Flow Requirements and Full Water Supply Diversions, and Diversion Deficits for 1922–2015

21.10 Adaptive Implementation Measures for Consideration

The adaptive implementation methods described in Chapter 3, *Alternatives Description*, could potentially be implemented in all years, including during dry years (less than average runoff), to manage flows in a manner that allows consideration of other beneficial uses, such as water supply for agricultural and municipal uses, as long as intended benefits to fish and wildlife beneficial uses are not reduced. Below is a summary of the four adaptive implementation methods, each of which allows changes based on best available scientific information.

1. Adjust the specified annual February–June unimpaired flow[4] requirement by either increasing or decreasing the requirement to a percentage within the specified range. For LSJR Alternative 2 (20 percent unimpaired flow), the percent of unimpaired flow may be increased to a maximum of 30 percent. For LSJR Alternative 3 (40 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 30 percent or increased to a maximum of 50 percent. For LSJR Alternative 4 (60 percent unimpaired flow), the percent of unimpaired flow may be decreased to a minimum of 50 percent.

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[4] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

2. Allow the total amount of water during February through June period to be managed as a total volume and released at varying rates, rather than maintaining a constant percentage of unimpaired flow.
3. Release a portion of the February through June unimpaired flow volume after June to prevent adverse effects to fisheries from implementation of the February through June unimpaired flow requirement. The volume of water to be shifted to later in the year would be limited as described in Chapter 3.
4. Modify the February–June Vernalis base flow requirement of 1,000 cfs to a rate between 800 and 1,200 cfs.

The flexibility afforded by adaptive implementation using the four methods may be especially useful during dry years as a means of reasonably protecting fish and wildlife beneficial uses. As described in this chapter, dry years with less than 75 percent of the average runoff occur in about 40 percent of the years (4 out of 10 years). All beneficial uses would likely face water deficiencies in dry years, but adaptive implementation may allow flexibility in managing limited water supplies for fish and wildlife while considering other beneficial uses, provided that these other considerations do not reduce benefits for fish and wildlife.

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Chapter 22
Integrated Discussion of Potential Municipal and Domestic Water Supply Management Options

22.1 Introduction

This chapter provides an integrated discussion of potential municipal and domestic water supply management options in response to implementation of the Lower San Joaquin River (LSJR) alternatives. Southern Delta water quality (SDWQ) alternatives are not discussed in this chapter, because a substantial degradation of water quality affecting service providers diverting drinking water from the southern Delta would not occur. This chapter incorporates information from Chapter 9, *Groundwater Resources*, and Chapter 13, *Service Providers*, in order to illustrate how potential impacts from LSJR alternatives would affect water supply to urban and rural populations in the San Joaquin Valley under current regulatory conditions. Current regulatory conditions include the Sustainable Groundwater Management Act (SGMA) (Wat. Code, § 10720 et seq.), which took effect January 1, 2015, and requires the formation of local agencies to protect and manage groundwater resources. SGMA is discussed in more detail below. This chapter also references project overview information from Chapter 1, *Introduction*; water resources and management descriptions from Chapter 2, *Water Resources*; project alternative descriptions from Chapter 3, *Alternatives Description*; and, cost information from Chapter 16, *Evaluation of Other Indirect and Additional Actions*.

This chapter summarizes: water use; the regulatory background for current and future groundwater management; potential impacts on public water supplies and domestic (i.e., private) wells; costs of potential management responses by municipal and domestic users; and the availability of financial and technical assistance programs to help address potential impacts. This chapter also discusses public health, with a special emphasis on disadvantaged communities (DACs)[1] and schools.

This chapter relies on the analyses in Chapters 9 and 13. Chapter 9 analyzes the potential impacts on groundwater as a resource as determined by reductions in groundwater levels and the risk of subsidence. Chapter 13 includes an examination of whether implementation of the LSJR alternatives could potentially require or result in: (1) construction of new water supply facilities or wastewater treatment facilities, or the expansion of existing facilities; or (2) violation of any drinking water quality standards. The study area as used in this chapter is the primary area likely to experience groundwater effects associated with the LSJR alternatives (i.e., the four main groundwater subbasins—the Eastern San Joaquin, Modesto, Turlock, and the “Extended" Merced Subbasin[2]), as defined in Chapter 9 (Figure 9-1).

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[1] *Disadvantaged communities* are defined as those communities with an annual median household income (MHI) that is less than 80 percent of the statewide annual MHI. (Public Resources Code, § 75005 subd. (g).)

[2] As described in Chapter 9, *Groundwater Resources*, the Merced Subbasin was extended for the analysis to include a part of the Chowchilla Subbasin.

The impacts of the LSJR alternatives on groundwater resources cannot be determined with certainty because groundwater conditions vary within each aquifer subbasin and water users would have varied responses to reduced surface water deliveries and any decrease in groundwater elevations. In addition SGMA, mentioned above, will improve groundwater management as it places a mandatory duty upon local agencies in high and medium priority groundwater basins, including those in the study area, to form groundwater sustainability agencies (GSAs) by June 30, 2017 and adopt and implement groundwater sustainability plans (GSPs) to sustainably manage groundwater resources.[3] Upon GSP adoption, SGMA grants the local GSA specific authorities to manage and protect its groundwater basin including, but not limited to, the ability to require reporting of groundwater withdrawals and to control groundwater extractions by regulating, limiting, or suspending extractions from wells. (Wat. Code, § 10726.4.) If a local agency is unwilling or unable to manage its groundwater resources to prevent undesirable results as defined under SGMA, which include but are not limited to chronic lowering of groundwater levels or migration of contamination, then SGMA empowers the state to provide interim management until local agencies are able to assume management. SGMA is discussed in more detail in Section 22.3, *Regulatory Background.*

22.2 Water Supply

This section summarizes the two major uses of water in the study area (Figure 9-1): irrigation and drinking water. This section focuses on drinking water supply from both surface water and groundwater, but also describes agricultural water use, mainly in the form of irrigation, to put competing water demands in the study area in context.

22.2.1 Water Use

Irrigation districts and water districts (collectively referred to as irrigation districts hereafter) supply water for multiple uses (i.e., agricultural, municipal and industrial) within the study area. They obtain water by either diverting surface water from the three eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers), pumping groundwater from aquifers, or both. Irrigation districts primarily deliver water to a distribution system for crop irrigation. Although these districts serve primarily agricultural supplies, in some cases they also supply local municipalities through existing agreements. Additionally, these districts may also provide hydropower to their service areas. There are also individuals and entities in the study area that use domestic wells to meet their water needs, and riparian diverters that directly deliver water for crop irrigation. A summary of the irrigation district and riparian diversions from the LSJR tributaries is presented in Table 2-3.

A significant portion of California's water supply needs is met by groundwater. Typically, groundwater supplies about 30 percent of California's urban and agricultural uses. In dry years, groundwater use increases to about 40 percent statewide and 60 percent or more in some regions (DWR 2003a). In the San Joaquin River Hydrologic Region, groundwater contributed approximately 38 percent (3.2 million acre-feet [MAF]) to the 2005–2010 average annual total water supply.

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[3] The Modesto and Turlock Subbasins are listed as high-priority basins, and the Eastern San Joaquin, Merced, and Chowchilla Subbasins are listed as high-priority and critically overdrafted basins. Plans for critically overdrafted basins subject to SGMA must be adopted by January 31, 2020. The deadline to adopt plans for all other basins subject to SGMA is January 31, 2022. See the Sustainable Groundwater Management Act discussion in Section 22.3, *Regulatory Background.*

Groundwater supplies, based on average annual estimates for 2005–2010, contribute 36 percent of the total agricultural water supply, 58 percent of the total urban water supply, and 38 percent of the total managed wetlands supply in the San Joaquin River Hydrologic Region (DWR 2015a).

Irrigation districts pump groundwater to supplement their water supply when surface water is in shortage. Many private growers who are not served by an irrigation district also pump groundwater to irrigate their crops. More than half of all land within the subbasins is irrigated agriculture, which is the largest user of groundwater. Many cities and towns in the study area also rely on groundwater either wholly or partially to for their drinking water supply.

While surface water is the major source of irrigation and provides significant contribution to groundwater recharge, groundwater levels in the San Joaquin Valley Groundwater Basin have generally declined as a result of extensive pumping. As discussed in Chapter 9, *Groundwater Resources*, the Modesto, Turlock, and Merced Subbasins have experienced varying degrees of overdraft and recharge conditions between 1970 and 2000. Each subbasin experienced a net overdraft condition between 1970 and 2000, as indicated by average declines in groundwater elevation of approximately 15, 7, and 30 feet (ft), respectively, with the eastern portion of the subbasins experiencing more severe overdraft (DWR 2003c, 2003d, 2003e). It is estimated that the groundwater storage in the Turlock Subbasin decreased by an average of 21.5 thousand acre-feet per year (TAF/y) during the period of 1997–2006 (TGBA 2008). The Eastern San Joaquin Subbasin has been in a consistent overdraft condition (approximately 1.7 ft/yr) for the same time period. It is estimated that the overdraft has reduced storage in the Eastern San Joaquin Subbasin by 2 MAF over a 40-year period (DWR 2003b), 50 TAF/y on average. According to a recent California Department of Water Resources (DWR) review, two of the four groundwater subbasins underlying the study area (Eastern San Joaquin and Merced) are critically overdrafted (DWR 2016). Groundwater pumping in the region continues to increase in response to growing demand and reduced surface water deliveries. Additional pumping in any of these subbasins could reduce the average groundwater level (i.e., drawdown), with a noticeable effect on groundwater levels over a number of years.

22.2.2 Water Quality

As discussed in Chapter 5, *Surface Hydrology and Water Quality*, surface water quality is very good in the three eastside tributaries,[4] with an average salinity (as measured by electrical conductivity [EC][5]) value of less than 0.1 deciSiemens per meter (dS/m) near the confluence with the San Joaquin River. The water quality of the Stanislaus, Tuolumne, and Merced Rivers is primarily affected by reservoir operations and agricultural return flow. EC generally increases as water moves downstream in all three rivers due to the relatively high EC in agricultural drainage and groundwater discharges to the river. Chloride, bromide, sulfate, and boron are specific ions that contribute to overall salinity and are constituents of concern. However, of these constituents of concern, in the plan area only boron is included on California's statewide list of impaired

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[4] In this document, the term *three eastside tributaries* refers to the Stanislaus, Tuolumne, and Merced Rivers.

[5] In this document, EC is *electrical conductivity*, which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

waterbodies (303(d) list).[6] Boron and salinity can affect multiple beneficial uses, including the yield of crops that are sensitive to these constituents. Additionally, high EC values in source water may limit the ability to utilize recycled water. The presence of bromide in municipal water sources is also a concern because bromide is the precursor to the formation of harmful byproducts of the water disinfection process. However, there are no 303(d) listings for bromide. In addition, the Stanislaus, Tuolumne, and Merced Rivers are identified on the 303(d) list for constituents associated with agricultural uses, including pesticides (e.g., chlorpyrifos and diazinon), and temperature (State Water Board 2011).

As discussed in Chapter 9, *Groundwater Resources*, groundwater quality can be affected by many factors, both natural (e.g., substrate material) and anthropogenic (e.g., land use). Therefore, groundwater quality varies substantially throughout the San Joaquin Valley Groundwater Basin. In general, groundwater in the San Joaquin River Hydrologic Region is suitable for most urban and agricultural uses. Groundwater in shallower aquifers generally contains higher concentrations of anthropogenic contaminants, such as nitrates and pesticides, than in deeper aquifers (DWR 2015a). In addition to agricultural and industrial sources, trace elements (such as arsenic, manganese, vanadium and uranium) that naturally occur in rocks and soils can come in contact with the water and present water quality problems. See Chapter 13, *Service Providers*, for further information on quality of groundwater used as a drinking water source.

In general, municipal drinking water wells do not exceed federal and state maximum contaminant levels (MCLs). This is because municipal wells are generally deep, and water quality tends to be better in deeper aquifers. Furthermore, water quality is managed such that if drinking water standards are violated at a public well, the well will be brought offline and corrective actions will be taken to ensure the water will meet the MCL requirement before it is delivered the consumers. For example, dibromochloropropane (DBCP) was detected over the MCL at two of the City of Atwater's wells. Granular activated carbon filtering systems were installed on these water sources to remove the contaminant prior to introduction of water into the City's water system (City of Atwater 2015). The City of Livingston, located in the Merced Subbasin, recently improved filtration in order to reduce arsenic concentrations that were above the state MCL (Giwargis 2014).

Water quality in community water systems is frequently monitored by the State Water Board and the service providers pursuant to various regulatory requirements (discussed in Chapter 13, Section 13.3, *Regulatory Background*). Community water systems must provide annual drinking water quality reports, known as consumer confidence reports (CCRs), to their customers. Table 13-5 of Chapter 13 provides information from CCRs of select municipalities in the groundwater subbasins during representative non-drought and drought years.

Private drinking water wells may have more significant water quality issues than municipal wells because they are often shallower than municipal wells and, therefore, are more susceptible to surface contaminants. However, the State does not regulate the water quality of private drinking water wells, and does not require private drinking water well owners to test for water quality. As such, there is a lack of water quality data for private drinking water wells in the study area.

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[6] Clean Water Act section 303(d) requires states, territories, and authorized tribes to develop a ranked list of water quality limited segments of rivers that do not meet water quality standards.

22.2.3 Municipal Water Use and the Current Drought

There are approximately 1.2 million people living in the four groundwater subbasins (U.S. Census Bureau 2010). Of this population, approximately 1.1 million people, or 89 percent, receive some portion of their water supply from a public water supplier (California Environmental Health Tracking Program 2016). The remaining 11 percent, equivalent to approximately 133,000 people, rely solely on domestic wells for their water supply. However, due to a lack of records, it is difficult to determine the actual number of people currently relying on domestic wells. Using 635,000 scanned well-completion reports provided by DWR in 2011, and based on a spatially distributed and randomized survey, Johnson and Belitz (2015) estimated that there are 37,386 domestic wells in the six counties that are within or intersect the study area (Table 22-1).

Ninety-three public water suppliers were identified within the four groundwater subbasins (California Environmental Health Tracking Program 2016; State Water Board 2016). Table 13-3a, in Chapter 13, *Service Providers*, lists those public water suppliers, the population served in 2014, and the reliance on groundwater supply (as a percentage of total water supply) in 2014. Many of these water suppliers rely solely or partially on groundwater for their water supply. In 2014, groundwater supplied 52 percent of the 91 public water suppliers’ total water production; the remaining 48 percent of the total water production came from surface water or recycled water. California’s current drought (2012–present) has left many public water suppliers struggling to deliver water to their customers and caused many domestic wells to go dry. The following are examples of public water supplier responses to ensure adequate water supplies during the drought.

Stockton East Water District (SEWD)

SEWD, a water wholesaler, used surface water solely between 2010 and 2014. During this time, SEWD had two inactive drinking water wells intended only for use as emergency or dry year supplies. In February, 2015, the U.S. Bureau of Reclamation (USBR) announced its zero initial water allocation for many agricultural users north and south of the Delta, including SEWD, which received zero percent of their contract quantity due to a lack of available Central Valley Project (CVP) supplies out of New Melones Reservoir (Martineau 2015). In response, SEWD reactivated the two wells, built a new well, and converted two old irrigation wells into drinking water wells in 2015. The changes were permitted by the State Water Board. SEWD now has five active wells, and uses both surface water and groundwater as its sources of water supply (Sahota pers. comm.).

Le Grand Community Service District

Le Grand Community Service District, which serves 1,700 people in Merced County, has three wells. In 2014, one well, which was drilled in 1966, collapsed due to its age, and another well had a valve failure With financial assistance from the State's Drought Emergency Fund, the district rehabilitated the two wells and was able to extract groundwater again. Repairing the wells alleviated the emergency situation; however, water shortages are still a problem. The third well capacity has dropped to 200 gallons per minute and requires new equipment to achieve its maximum production of 1,000 gallons per minute (Giwargis 2014; Chauhan pers. comm.). Furthermore, the District Superintendent, Richard Kilgore II, stated that the local water table (in the Merced Subbasin) was dropping fast (Giwargis 2014).

Plainsburg Elementary School

Plainsburg Elementary School, located near Le Grand, has one well. In 2014, the well went dry and was abandoned. With financial assistance from the State's Drought Emergency Fund, the school constructed a new, deeper well near the old well. The old well was approximately 250 ft deep and the new well is 600 ft deep (Chauhan pers. comm.).

22.2.4 Domestic Wells and Household Water Shortages

In general, public wells are deeper than domestic wells, because private entities do not have the resources to drill deep into the ground. Due to their shallower depth, under drought conditions, domestic wells tend to go dry before public wells. In California, water systems with fewer than 15 household connections, including individual household wells or water supplies, are regulated at the county level. Counties vary in their practices, but rarely do counties collect data regularly from these very small and individual household water supplies. Even where data is collected it is entirely voluntary. As the drought developed, local and state agencies began receiving anecdotal reports of household water shortages. In 2014, DWR led an effort to put these reports in a centralized database. Table 22-1 shows the cumulative numbers of well outages[7] reported to DWR between January 2014 and April 5, 2016 (DWR 2016), and the percentage of outages for each county that intersects the study area. Most reported outages are for wells that serve 1-2 households (Fencl pers. comm.).

Table 22-1. Number of Domestics Wells and Number of Well Outage Reported

County	Number of Domestic Wells	Number of Well Outage Reported[a]	% of Outage
Calaveras	4,873	1	0.02
Mariposa	5,276	172	3.3
Merced	6,209	160	2.6
San Joaquin	7,666	25	0.3
Stanislaus	8,980	227	2.5
Tuolumne	4,382	234	5.3
Total	37,386	819	2.2

Source: Johnson and Belitz 2015; State of California 2016

[a] Cumulative report of household water shortages by county reported to the State, January 2014–April 5, 2016.

22.3 Regulatory Background

This section discusses current and future regional or local program, policies, and regulations related to managing current and future water supplies. Regulations related to managing groundwater resources are in Chapter 9, *Groundwater Resources*; regulations related to service providers are in Chapter 13, *Service Providers*. Select regulations from these chapters are presented below.

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[7] Outage means the well has gone completely dry, is experiencing very low flow, or has pump issues such that no water can be pumped out of the well.

22.3.1 Current Planning Efforts

It is the state's policy that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. (Wat. Code, § 106.3.) In addition, it is the state's policy that "groundwater resources be managed sustainably for long-term reliability and multiple economic, social, and environmental benefits for current and future beneficial uses" and that sustainable groundwater management "is best achieved locally through the development, implementation, and updating of plans and programs based on the best available science." (Wat. Code, § 113.) Referenced below are relevant state and regional policies and plans related to current planning efforts to ensure a reliable water supply in the future.

Sustainable Groundwater Management Act

As discussed in Section 22.1, *Introduction,* and Chapter 9, *Groundwater Resources*, SGMA provides the framework to implement the state's sustainable groundwater management policy by requiring that local agencies in high- and medium-priority basins[8] form GSAs by June 30, 2017 that will develop and implement GSPs that achieve sustainable groundwater management within 20 years. The four main groundwater basins in the plan area—the Eastern San Joaquin, Modesto, Turlock, and Merced subbasins—are all high-priority subbasins, as is the Chowchilla Subbasin. Basins in a critical condition of overdraft, including the Eastern San Joaquin, Merced, and Chowchilla Subbasins, must achieve sustainability by 2040; all other high- and medium-priority basins must achieve sustainability by 2042. Importantly, SGMA does not require GSP approval at the state level before a GSA can implement measures to protect groundwater resources. SGMA's management and enforcement powers attach upon adoption of a GSP by the local GSA.

SGMA is intended to promote coordinated management of a groundwater basin through GSA formation and requires GSAs to consider the interests of all beneficial uses and users of groundwater, including domestic well owners, municipal well operators, public water systems, disadvantaged communities, and tribes in developing and implementing a GSP. SGMA requires a GSP to provide for "the management and use of groundwater in a manner that can be maintained during the [50-year] planning and implementation horizon without causing 'undesirable results.'" (Wat. Code, § 10721 subd. (v).) *Undesirable results* include, but are not limited to:

- Chronic lowering of groundwater levels (not including overdraft during a drought if a basin is otherwise managed).
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

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[8] One hundred twenty-seven of California's 515 alluvial groundwater basins, which account for 96 percent of California's annual groundwater pumping, were identified as high- or medium-priority (DWR 2014). Prioritization factors include, but are not limited to, the level of population overlying the basin or subbasin, the projected rate of population growth for the basin or subbasin, the number of public supply wells dependent on the basin or subbasin, the irrigated acreage overlying the basin or subbasin, and the degree of reliance on groundwater (Wat. Code, § 10933, subd. (b).)

- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Depletions of interconnected surface water that have significant and unreasonable adverse effects on beneficial uses of the surface water.

If local agencies are unwilling or unable to manage their groundwater resources, SGMA authorizes the State Water Board to step in to protect a groundwater basin in limited circumstances: (1) if no agency has opted by June 30, 2017 to serve as a GSA for a basin, (2) when a GSA does not complete a GSP by the relevant deadline (2020 or 2022), or (3) when the GSP is inadequate or the GSP is not being implemented in a manner that is likely to achieve the plan's sustainability goal(s), and the basin is either in a condition of long-term overdraft or, after January 31, 2025, the State Water Board determines that the basin is in a condition where groundwater extractions result in significant depletions of interconnected surface waters.

Integrated Regional Water Management Planning

Integrated Regional Water Management (IRWM) Planning is a collaborative stakeholder process that promotes sustainable water use. IRWM Planning identifies and implements water management efforts on a regional scale to ensure sustainable water uses, reliable water supplies, better water quality, efficient urban development, protection of agriculture, environmental stewardship, and a strong economy. IRWM plans (IRWMPs) acknowledge that regions have distinct identities and hydrologic and ecologic conditions, and that water supply reliability should be a primary water management objective to be considered in these integrated plans.

Urban Water Management Plans

The California Urban Water Management Planning Act (UWMPA) requires California's urban water suppliers[9] to initiate planning strategies to ensure the appropriate level of reliability in their water service to meet the needs of the various categories of customers during normal, dry, and multiple dry years. To do this, urban water suppliers must prepare an UWMP every 5 years. UWMPs serve as a resource for planners and policy makers over a 25-year planning time fame, and include information about groundwater and surface water supplies, historic and projected water use, recycled water, water use efficiency programs in a contracting water district's service area, and contingency planning for the possibility of water shortages.

2015 UWMPs (due to DWR by July 1, 2016) do not reflect new requirements for groundwater management under SGMA. However, DWR recommended that 2015 UWMPs include a discussion of current or planned activities to meet anticipated SGMA requirements (DWR 2016). 2010 UWMPs that are relevant to the irrigation districts and four subbasins are summarized in Table 9-11; 2010 UWMPs that are relevant to the urban water suppliers are summarized in Chapter 13, *Service Providers*. UWMPs vary in terms of water shortage management responses and implementation methods included.

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[9] Urban water suppliers are defined as suppliers that have 3,000 or more water connections or provide over 3,000 acre-feet of water annually.

Water Shortage Contingency Plan

A reliable water supply is essential and its importance highlights the necessity to prepare for the possibility of drought. Contingency planning before a water shortage allows for a selection of appropriate responses consistent with the varying severity of shortages. To prepare for the possibility of water shortages, UWMPs include a Water Shortage Contingency Plan (WSCP). The WSCP enables the urban water supplier to provide water for public health and safety and minimize impacts on economic activity, environmental resources, and the region's economic health. Examples of priorities for use of available water include the following.

- Health and Safety – interior residential and firefighting.
- Commercial, Industrial, and Institutional – maintain economic base, protect jobs.
- Permanent Crops – takes 5 to 10 years to replace.
- Annual Crops – protect jobs.
- Landscaping – direct water to trees and shrubs.
- New Demand – typically, 2 years of construction projects that are already approved.

Several WSCPs have been developed in the counties that intersect the plan area. While WSCPs vary in terms of water shortage management responses and implementation methods included, all WSCPs include: (1) a description of the stages of action an agency will take in response to water shortages; (2) an estimate of supply for three consecutive years; (3) a plan for dealing with a catastrophic supply interruption; (4) a list of the prohibitions, penalties, and consumption reduction methods to be used; (5) an analysis of expected revenue effects of reduced sales during shortages and proposed measures to overcome those effects; and (6) how the supplier will monitor and document cutbacks.

Water Conservation Act of 2009 (Senate Bill X7-7)

SBX7-7, the water conservation bill passed as part of the 2009 Comprehensive Water Package, requires urban and agricultural water suppliers to increase water use efficiency. SBX7-7 requires urban water suppliers to achieve an interim goal of achieving at least a 10 percent reduction in per capita water usage by 2015 and a 20 percent reduction in per capita water usage by 2020. Additionally, all suppliers were required to determine baseline water use and set reduction targets according to specified requirements.

Several urban and agricultural water suppliers in the counties that intersect the plan area are required to report on progress towards the savings goal. Implementation methods and the level of savings achieved varies by supplier.

22.3.2 Managing Water Supplies under Reduced Water Availability Conditions

Emergency Urban Water Conservation

In April 2015, Governor Edmund G. Brown Jr issued Executive Order (EO) B-29-15, which called for a statewide 25 percent mandatory conservation by urban water suppliers in preparation for the possible continuation of the drought. In response to EO B-29-15, the State Water Board adopted

Resolution 2015-0032, which assigned each of the state's urban water suppliers a conservation standard that ranged between four percent and 36 percent, based on the supplier's residential gallons per capita per day (R-GPCD). The tiered conservation standards accounts for water conservation already achieved by communities based on relative per capita water usage. The compliance period for achieving the statewide mandatory 25 percent savings goal and supplier-specific conservation standards was June 2015 through February 2016. Water use for the same months during 2013 acted as the baseline for calculating water savings. In response to EO B-37-16, issued in May 2016, the State Water Board adopted a modified version of the emergency urban water conservation regulations, extending revised conservation standards through January 2017.

There are 15 urban water suppliers in the study area that were required to achieve water conservation standards for the compliance period. In response to reporting associated with mandatory statewide water conservation regulations, detailed per capita residential water use information is available for 15 water suppliers in the counties that intersect the study area. The residential water use reported by these 15 water suppliers accounted for, on average, approximately 68 percent of their total water production (172 thousand acre-feet [TAF] out of their total production of 253 TAF in 2013). During the compliance period (June 2015-February 2016), the 15 suppliers reported an average cumulative savings of 26 percent, as compared to the total water use for the same months in 2013, with individual supplier savings ranging from 8 to 42 percent (Table 22-2). While supplier success towards achieving their conservation standard varied, all 15 urban water suppliers reported reduced residential water use between 2013 and 2015/16. Average residential water use declined from 148 R-GPCD in 2013, to 106 R-GPCD during the 2015/16 compliance period. This decline represents an overall annual reduction of 47 TAF/y for these 15 water suppliers. If applied to all residential use in the plan area, this represents a potential reduction of 61 TAF/y.

22.3.3 Planning for Future Water Needs

Water is critical to future population and economic growth, and can also be the major limiting factor to growth. Planning for future water needs requires examining current demand and supply pressures, looking at trends within each, and promoting and implementing sustainable and efficient water management practices. However, water management does not happen in isolation. A coordinated, integrated approach is essential to ensure adequate water supplies for future needs. This is accomplished through urban planning (including city and county general plans, water master plans, recycled water master plans, integrated resources plans, IRWMPs, UWMPs, and groundwater management plans). New planning efforts are greatly enhanced when they rely upon the information found in all planning documents within their service area and neighboring service areas.

Meeting future water needs includes ensuring adequate supplies for projected urban population growth, current and future projects, and preparing for climate change impacts on water supplies and possible water shortages. As highlighted by the recent drought, the unreliable nature of municipal water supplies emphasizes the need for communities to develop and manage local resources through strategies such as water use efficiency and conservation, recycled water, and groundwater recharge.

Table 22-2. Urban Water Conservation and Residential Water Use

Urban Water Supplier	Principal County Served	Groundwater Subbasin	Groundwater Reliance in 2014 (%)	Population Served	% Cumulative Water Savings (Jun-15–Feb-16, compared to 2013)	Conservation Standard (Jun-15 – Feb-16; %)	Average R-GPCD (Jun-15 – Feb-16)	Average R-GPCD (Jan-Feb 2013)[a]
Atwater	Merced	Merced[b]	100	29,167	42.1[c]	36	171 [c]	201
Cal Water, Stockton	San Joaquin	Eastern San Joaquin	26	169,682	21.8	20	64	83
Ceres	Stanislaus	Turlock	100	45,884	24.0	28	85	116
Lathrop	San Joaquin	Eastern San Joaquin	88	19,831	28.3	20	84	117
Livingston	Merced	Merced	100	14,894	16.8	32	97	117
Lodi	San Joaquin	Eastern San Joaquin	73	63,651	26.5	32	107	145
Manteca	San Joaquin	Eastern San Joaquin	42	73,808	29.6	32	98	143
Merced	Merced	Merced	100	83,400	37.1	36	137	217
Modesto	Stanislaus	Modesto	61	217,269	27.8	36	129	182
Oakdale	Stanislaus	Modesto	100	21,772	39.0	32	112	185
Ripon	San Joaquin	Eastern San Joaquin	100	14,915	27.4	36	161	223
Riverbank	Stanislaus	Modesto	100	23,024	7.9	32	127	58 [d]
Stockton	San Joaquin	Eastern San Joaquin	23	173,893	26.7	28	89	25
Turlock	Stanislaus	Turlock	100	71,064	25.7	32	113	153
Winton WSD	Merced	Merced	100	8,500	21.7	36	121	155
Total for All Populations Served				1,030,755	27.8	NA	106	148

Sources: State Water Board 2014; State Water Board 2016.

R-GPCD = Residential Gallons Per Capita Per Day

NA = Not Applicable

WSD = Water Service District

[a] 2013 R-GPCD is calculated using residential gallons and population from Jun-14 through Feb-15 reports.

[b] As described in Chapter 9, *Groundwater Resources*, the Extended Merced Subbasin includes a portion of the Chowchilla Subbasin.

[c] Based on Jun-15—Nov-15 monthly water conservation reports.

[d] Missing Aug-14 monthly water conservation report.

UWMPs provide a framework for long-term water planning and ensuring adequate water supplies for existing and future demands. These plans require urban water suppliers to coordinate with local planning agencies to assess future growth and related water demand growth. Planning for future water demands may be based on projected development, population growth, and expected future projects and programs during average, single-dry, and multi-dry years. Plans also need to include, to the extent practicable, a description of any constraints on the agency's water supply, such as inconsistent availability or water quality issues, that the water agency has identified, as well as the management strategies that have been, or will be, employed to address the constraint (DWR 2015b).

22.4 Impact Analysis

This section describes the potential impact the LSJR alternatives may have on drinking water supply.

22.4.1 Potential Impacts of LSJR Alternatives

Implementation of the LSJR alternatives would reduce surface water available for diversion. Table 22-3 shows the average annual surface water diversion in baseline and the expected reduction in each LSJR alternative relative to baseline. See Appendix F.1, *Hydrologic and Water Quality Modeling*, for a detailed description of the hydrologic modeling that produces this result.

Table 22-3. Average Annual Change in Surface Water Diversion Compared to Baseline in the Plan Area

River	Average Baseline SW Diversion (TAF/y)	Change in SW Diversion Relative to Baseline (TAF/y)		
		LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Stanislaus	637	-12	-79	-206
Tuolumne	851	-20	-119	-298
Merced	580	-33	-95	-185
Total	2,068	-65	-293	-689

SW = surface water
TAF/y = thousand acre-feet per year

As discussed in Chapter 9, *Groundwater Resources*, LSJR Alternative 2 would have a less-than-significant impact on groundwater as a resource, while LSJR Alternatives 3 and 4 would have significant and unavoidable impacts on groundwater as a resource. That is, under LSJR Alternatives 3 and 4, the average annual groundwater balance is expected to be reduced by more than the equivalent of 1 inch in three subbasins (Modesto, Turlock, and Extended Merced) and all four subbasins, respectively. Exceeding the 1-inch threshold would eventually result in a measurable decrease in groundwater elevations in the basins. Therefore, it is expected that LSJR Alternatives 3 and 4 would result in a substantial depletion of groundwater supplies or substantial interference with groundwater recharge.

As discussed in Chapter 13, *Service Providers*, under LSJR Alternative 2, there would not be a substantial reduction of surface water or a substantial depletion of groundwater supplies. Therefore, LSJR Alternative 2 would have a less-than-significant impact on service providers.

However, under other LSJR alternatives (Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with and without adaptive implementation), there would be substantial reductions of surface water and depletion in groundwater supplies. For details of which subbasin and service providers would be impacted under each alternative, see Chapter 13. These LSJR alternatives would potentially require service providers to construct new water supply facilities or wastewater treatment facilities or expand existing facilities, the construction of which could cause significant environmental effects. In this regard, these alternatives would have a significant and unavoidable impact on the environment related to the construction of new or expanded facilities.

Furthermore, due to increased groundwater pumping as a result of implementation of LSJR Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with and without adaptive implementation, the quality of groundwater as a source of drinking water in the study area could potentially be degraded. However, a substantial increase in groundwater pumping would not necessarily result in an increase in violations of drinking water quality standards. During the recent drought, the amount of groundwater pumped for drinking purposes and the service providers' reliance on groundwater greatly increased and yet there was not a greater number of MCL violations as compared to a wet year based on CCRs prepared by the service providers (Table 13-5). In addition, public water systems are regulated by the state; if a drinking water quality problem is detected, the service provider would have to take corrective actions to ensure that the water is in compliance with relevant drinking water standards before it is served to the public. Therefore, under these alternatives, it is not expected that the quality of groundwater used for public water systems would be affected such that violations of water quality standards would occur. Accordingly, impacts would be less than significant.

In contrast to drinking water served by public water systems, LSJR Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with and without adaptive implementation may result in the use of contaminated groundwater for drinking water by domestic wells. While it is true that pumping greatly increased during the drought and yet there was not a greater number of MCL violations as compared to a wet year based on CCRs provided by service providers, there is a lack of information to support that this was also the case for private domestic wells. In addition, domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act (discussed in Chapter 13, Section 13.3, *Regulatory Background*). Therefore, there is no required mechanism to prevent private domestic wells from using groundwater that exceeds MCLs. Thus, under these alternatives, there is a potential for the quality of groundwater used in private domestic wells to be affected such that violations of water quality standards would occur. Accordingly, impacts would be significant.

Groundwater Pumping

Pumping within each irrigation district typically increases in dry years when surface water availability is reduced. Therefore, it is expected that, if surface water availability is reduced due to the LSJR alternatives, irrigation districts will respond by increasing groundwater pumping to compensate for a portion of the reduced surface water diversions. In the short-term, the amount of pumping would be limited by the existing capacity of the pumping facilities. However, in the long-term, irrigation districts might respond by deepening their wells or building more wells.

Public water suppliers are also expected to turn to groundwater to compensate for the loss of surface water available to them before additional water treatment or water recycle facilities are commissioned. The cities and communities that currently rely partially on groundwater would have to rely more heavily on groundwater. Such an increase in groundwater reliance will exacerbate the problem of declining groundwater level. The cities and communities that currently solely rely on groundwater might find their groundwater levels reduced and face the increased risk of wells going dry. They might have to deepen their wells or construct new wells to obtain the same groundwater production they currently have.

Dry well issues would affect both domestic and public supply wells. However, domestic wells, which are usually shallower than public wells, would be more likely to be affected by declining groundwater level than public wells. Additionally, because private well owners typically have fewer resources to deepen or construct new wells than public water suppliers, private well owners are likely to be more severely impacted by LSJR alternatives than public water suppliers. There could be more cases of dry wells or more well outages reported, as mentioned in Section 22.2, *Water Supply*.

Table 22-4 shows the expected annual increase of groundwater pumping relative to baseline in each of the LSJR alternatives assuming maximum groundwater pumping based on 2009 infrastructure. Average annual groundwater pumping for agricultural and residential uses by all entities (in and out of districts) in the study area is 2,038 TAF/y in baseline, and it is expected to increase by 23 TAF/y, 109 TAF/y and 224 TAF/y under LSJR Alternatives 2, 3, and 4 respectively.

Table 22-4. Estimated Effect of LSJR Alternatives on Average Annual Groundwater Pumping in the Study Area (Assuming Maximum Groundwater Pumping Based on 2009 Infrastructure)

GW Subbasin	Average Baseline GW Pumping (TAF/y)[a]	Average Change in GW Pumping Relative to Baseline (TAF/y)[b] LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Eastern San Joaquin	705	-4	23	69
Modesto	191	1	8	15
Turlock	507	2	16	30
Merced	635	23	61	110
Total	2,038	23	109	224

GW = groundwater

TAF/y = thousand acre-feet per year

[a] The average baseline pumping numbers are larger than those presented in Table G.3-3 because the numbers here are estimated for both in-district and out-of-district irrigation, but the numbers in Table G.3-3 are for in-district irrigation only.

A reduction in surface water supply would also affect the groundwater aquifer by simultaneously causing a reduction in groundwater recharge (due to a reduction in conveyance losses from the distribution system and in deep percolation from irrigated fields). Table 22-5 shows the expected annual net change in groundwater balance due to the surface water reduction under the LSJR alternatives. The groundwater balance for each subbasin is calculated as the sum of off-stream reservoir seepage, conveyance losses, and deep percolation from irrigation, minus total groundwater pumping. These components are not all of the inflows and outflows in a groundwater balance model. They are the only inflows and outflows that would be changed under the LSJR alternatives. Other inflows and outflows (such as infiltration from precipitation, recharge from out-of-district irrigated land, and net flux from/to the stream channels) are not included because they are assumed to remain unchanged in the alternatives. The total groundwater balance for the four subbasins in baseline is -994 TAF/y (positive means net recharge and negative means net pumping).

However, this is an over estimate and should not be used as an estimate of the overdraft in the four subbasins, because this groundwater balance does not take into account all components needed for a complete groundwater balance model. The key information is the difference in the groundwater balance between the baseline and the LSJR alternatives as shown in Table 22-5. The groundwater balance is expected to increase by 41, 186 and 411 TAF/y under LSRJ Alternatives 2, 3 and 4 respectively. As previously discussed in Section 22.2, the four groundwater subbasins underlying the study area have experienced varying degrees of overdraft. Increases in pumping due to the LSJR alternatives would exacerbate this problem.

Table 22-5. Estimated Effect of LSJR Alternatives on Average Annual Groundwater Pumping in the Study Area

	Average Change in GW Balance Relative to Baseline (TAF/y)		
GW Subbasin	LSJR Alt 2	LSJR Alt 3	LSJR Alt 4
Eastern San Joaquin	2	-36	-101
Modesto	-6	-25	-57
Turlock	-7	-43	-100
Merced	-30	-82	-152
Total	-41	-186	-411

Note: Positive values mean increase in net recharge; negative values mean increase in net pumping.

GW = groundwater

TAF/y = thousand acre-feet per year

As previously discussed in Section 22.2, groundwater overdraft in the Eastern San Joaquin Subbasin has been estimated to be 50 TAF/y (DWR 2003a) and groundwater storage in the Turlock Subbasin decreased by an average of 21.5 TAF/y (TGBA 2008). These numbers suggest a mean annual rate of groundwater overdraft of approximately 72 TAF/y for the combined Eastern San Joaquin and Turlock Subbasins. The current rate of overdraft in the Merced and Modesto Subbasins is not known, but if a similar combined rate of overdraft is assumed, the current rate of groundwater overdraft is approximately 144 TAF/y (2 x 72) in the subbasins. The 186 TAF/y increase in overdraft under LSJR Alternative 3 would slightly more than double this rate of overdraft to 330 TAF/y (144+186).

It is extremely difficult to provide perspective on the implications of these groundwater overdraft. The numbers beg the question of how long such levels of overdraft can be sustained. Estimates of groundwater storage made in the 1960s suggest that total aquifer storage in the four subbasins is on the order of 125 MAF (Williamson et al. 1989). This suggests that the current assumed rate of overdraft of 144 TAF/y represents approximately 0.12 percent of the total storage. The rate of overdraft under LSJR Alternative 3, 330 TAF/y, represents 0.26 percent of the total storage. These low percentages of total storage should not be taken to mean that these rates of groundwater overdraft do not pose a long-term problem with regard to sustainability. A number of other factors should be considered to make estimates and determinations of sustainability, including:

- It is difficult to quantify groundwater storage for a particular basin and essential data to make an accurate estimate are lacking (Faunt 2009). Even in basins where many studies have been completed, there are still many unknowns and conflicting findings.

- The estimates of storage in Williamson et al. (1989) are based on data collected in the 1960s and may not reflect current storage. No comprehensive estimate of groundwater storage for the four groundwater subbasins has been undertaken since 1961.
- These numbers assume that there is no groundwater movement between adjacent subbasins, and no changes in groundwater-surface water interactions.
- It is impossible to remove all water from storage by pumping. The deeper the well, the more difficult and expensive is it to drill and extract groundwater. At some point, it becomes economically infeasible to drill deeper.
- There will be very large associated effects, including subsidence and loss of recharge capacity, that occur long before all water in an aquifer could be removed.

This means that actions are needed now to address groundwater overdraft in this area, with or without the LSJR alternatives. This highlights the importance of implementing SGMA in areas in which there is already significant groundwater overdraft. This analysis also suggests that the timelines provided under SGMA afford sufficient time for water users in the plan area to develop and implement groundwater sustainability plans.

Groundwater Quality

As discussed in Chapter 9, *Groundwater Resources*, substantial additional groundwater pumping and reduction in groundwater level could occur in the subbasins under LSJR Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with and without adaptive implementation. Lowering the groundwater table could alter the direction and rate of the groundwater flow and create a hydraulic gradient between the well and surrounding saturated zone. This could potentially accelerate migration of surface contaminants to the well, cause saline water intrusion to the aquifer, mobilize naturally-occurring trace elements in the substrate, and elevate their concentrations in the aquifer (see Chapter 13, *Service Providers*, for a discussion of these processes).

However, the impact of groundwater pumping on groundwater quality depends on a number of different variables including, but not limited to, location and depth of the well, the amount of groundwater pumped and the frequency at which pumping occurs, number and proximity of nearby wells, hydrogeological characteristics of the aquifer, distance between the well and the contaminant(s), contaminant characteristics (e.g., highly mobile in water or adhering primarily to soil), and land use near the well. In addition, it is not possible to predict how the affected parties would respond to the reduction of surface water due to the LSJR alternatives. They may deepen existing wells or build new wells. If they build new wells, it is impossible to determine the number of new wells and their location. Thus while groundwater pumping can affect groundwater flow and quality, for all of the foregoing reasons, it is speculative to determine what that change in groundwater flow and its impact on groundwater quality would be from increased groundwater pumping.

The reduction in surface water supply would therefore affect entities that rely upon groundwater as their principal source of drinking water by: (1) increasing the need to deepen their wells or construct more wells to continue to access groundwater, (2) increasing groundwater pumping costs, (3) degrading groundwater quality, and (4) making groundwater unavailable in some areas in the long term as the groundwater level drops to a level that makes groundwater no longer accessible economically.

If LSJR Alternative 2 with adaptive implementation is implemented in a long term, or LSJR Alternatives 3 or 4 with and without adaptive implementation is implemented, it is expected that service providers relying on surface water supplies may need to find alternative supplies (e.g., groundwater). This could result in a potential degradation in groundwater quality and could impact those service providers (see Tables 13-3a and 13-3b in Chapter 13) and domestic well users relying on groundwater as source of drinking water.

However, a substantial increase in groundwater pumping would not necessarily result in contamination of groundwater used for drinking water for several reasons as described below.

1. During the recent drought, the amount of groundwater pumped for drinking purposes and the service providers' reliance on groundwater greatly increased and yet there was not a greater number of MCL violations as compared to a wet year based on the CCRs prepared by the service providers (Table 13-5 in Chapter 13).
2. While drinking water quality standard exceedances have been detected at the wellhead in different locations in the area of potential effects, these exceedances reflect raw, untreated groundwater quality. Service providers would have to take actions to ensure that the water is in compliance with relevant drinking water standards before it is served to the public. Such actions include monitoring groundwater quality regularly, and if any exceedances are detected, bringing the well offline until the problem is rectified (Chapter 13, Section 13.3, *Regulatory Background*). Treatment options include blending, large-scale treatment systems, wellhead treatment systems, or Point-of-Use/Point-of-Entry water treatment systems used in homes or residences.
3. While increased groundwater pumping may expedite the migration of contaminants introduced at the land surface into the water table and flow towards the well, the effect would be localized, i.e., at the well (see Chapter 13, Section 13.2, *Environmental Setting*). Hence, it would be unlikely that such contamination would spread to other parts of the aquifer.

Therefore, under LSJR Alternative 2 with adaptive implementation, and LSJR Alternative 3 and 4 with and without adaptive implementation, it is not expected that the quality of groundwater used for public water systems would be affected such that violations of water quality standards would occur. Accordingly, impacts would be less than significant.

An additional factor that would keep this impact less than significant is that SGMA would provide controls on the degradation of groundwater quality. As discussed in Section 22.3.1, *Current Planning Efforts*, under SGMA, local agencies in high- and medium-priority basins are required to form groundwater sustainability agencies by June 30, 2017, that will develop and implement GSPs that achieve sustainable groundwater management within 20 years. Sustainable groundwater management includes not causing chronic lowering of groundwater levels and significant and unreasonable degradation of water quality, including the migration of contaminant plumes that impair water supplies. GSPs must be adopted by January 31, 2020, for Eastern San Joaquin and Merced Subbasins. GSPs for Modest and Turlock Subbasins must be adopted by January 31, 2022. Upon GSP adoption, SGMA grants the local GSA specific authorities to manage and protect its groundwater basin including, but not limited to, the ability to require reporting of groundwater withdrawals and to control groundwater extractions by regulating, limiting, or suspending extractions from wells. If a local agency is unwilling or unable to manage its groundwater resources to prevent undesirable results as defined under the SGMA, which include but are not limited to chronic lowering of groundwater levels or migration of contamination, then SGMA empowers the state to provide interim management until local agencies are able to assume management.

Thus, under SGMA, groundwater subbasins will be managed both in terms of over-pumping and groundwater quality degradation from migrating contaminant plumes.

In contrast to drinking water served by public water systems, a substantial increase in groundwater pumping and decrease in groundwater levels may result in contamination of groundwater used for drinking water by private domestic wells under LJSR Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with and without adaptive implementation. While it is true that pumping greatly increased during the drought and yet there was not a greater number of MCL violations as compared to a wet year as reported by service providers, there is a lack of information to support that this was also the case for private domestic wells. Importantly, private domestic well users are largely unregulated and are under no state requirements to monitor, test, and treat their water to meet the state and federal Safe Drinking Water Act. Therefore, there is no required mechanism to prevent private domestic wells from using groundwaters that may exceed MCLs.

Therefore, under LSJR Alternative 2 with adaptive implementation, and LSJR Alternatives 3 and 4 with and without adaptive implementation, there is a potential for the quality of groundwater used in private domestic wells to be affected such that violations of water quality standards would occur. Accordingly, impacts would be significant.

The State Water Board does not have authority to require implementation of mitigation that could reduce this impact to a less-than-significant level, because it does not regulate private domestic wells. It can and does assist in identifying water quality threats through the Groundwater Ambient Monitoring and Assessment (GAMA) Program, the Board’s comprehensive groundwater quality monitoring program for California, and GeoTracker GAMA, which provides water quality data in California via the internet. For example, using the publicly available data collected in GAMA since 2000, State Water Board provides an online, map-based, tool, called “Is My Property Near a Nitrate-Impacted Water Well?,” which domestic owners can use to evaluate the risk of nitrate contamination to their well. The tool can be accessed at http://www.waterboards.ca.gov/water_issues/programs/nitrate_project/nitrate_tool/.

Possible mitigation measures owners and operators of private domestic wells should undertake to avoid or reduce potential drinking water impacts at private domestic wells include the following.

- Having a licensed contractor construct wells in accordance with well construction standards.
- Choosing a location for a well to make sure it is free of potential sources of contamination.
- Testing well water at certified drinking water laboratories to ensure its quality.
- Installing, if necessary, a water treatment system tailored to the overall water chemistry and constituents that need to be removed. Example systems include activated alumina filters, activated charcoal filters, air stripping, anion exchange, and ultraviolet radiation.
- Drilling, if necessary, a new well that taps into a cleaner aquifer or finding an alternative water source.
- Destroying properly of unused and abandoned wells to prevent contamination.

In addition, local agencies can and should exercise their police powers and groundwater management authority under SGMA, described above, to address groundwater contamination so as to prevent and/or mitigate drinking water impacts on private domestic wells. Specifically, under SGMA, local agencies in high- and medium-priority basins must form GSAs by June 30, 2017, that will develop and implement GSPs that achieve sustainable groundwater management within

20 years. Each GSP must also include measureable objectives as well as milestones in increments of 5 years, to achieve the sustainability goal in the basin within 20 years of the implementation of the plan. (Wat. Code, § 10727.2.) If local agencies are unwilling or unable to manage their groundwater resources, SGMA authorizes the State Water Board to step in to protect a groundwater basin, as discussed above.

Thus, at this time, local agencies are vested with the mandatory duty to achieve sustainable groundwater management, which includes preventing significant and unreasonable degradation to water quality. These agencies, therefore, can and should exercise their full authorities to address degradation of groundwater quality, both under SGMA and their police powers. Doing so would prevent and/or mitigate private domestic well drinking water supply impacts. Due to inherent uncertainty in the degree to which this mitigation and those listed above may be implemented by local agencies and owners and operators of private domestic wells, drinking water impacts on private domestic wells under LSJR Alternative 2 with adaptive implementation, and LJSR Alternatives 3 and 4 with and without adaptive implementation would remain significant and unavoidable.

22.4.2 Potential Impacts on Public Health

All Californians have a right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. Safe water is necessary for public health and community prosperity. The reduction in surface water supply could affect all entities that rely upon groundwater as a partial or primary source of drinking water, including end-users of municipal and public water systems, DACs, domestic well owners, and schools. The public health impacts associated with the LSJR alternatives on groundwater resources cannot be determined with certainty because groundwater conditions vary within each groundwater subbasin, and water users would have varied responses to reduced water deliveries. Communities and individuals will be affected differently by reduced water supply conditions, depending on several variables, including the following.

- Structure and capacity of existing water system.
- Economic development.
- At-risk populations living within the affected area.
- Local governance of water use.
- Other societal factors, such as the presence of local social networks.

Reduction in potable water supplies could results in directly observable and measurable health effects, such as compromised quality or quantity of potable water, diminished living conditions pertaining to sanitation and hygiene in the short term. Other, long-term chronic impacts, such as increased risk of mental or behavioral health issues, such as anxiety and other conditions and disorders (especially among persons who rely on water for their economic survival), increased risk to vulnerable people (e.g., persons suffering from chronic health conditions or immune disorders), and increased disease incidence for infections, chronic, and vector borne or zoonotic diseases are not always easy to anticipate or monitor (CDC et al. 2010).

The analysis of the plan amendment's[10] potentially significant impacts on service providers is in Chapter 13, *Service Providers*. That analysis includes an examination of whether implementation of the LSJR alternatives would lead to drinking water that exceeds standards and the potential for service providers to have to construct new or expanded facilities due to water quality or issues associated with reduced surface water diversions (i.e., reduced water supply). This section moves beyond the Chapter 13 analysis of impacts on service providers and to the environment, and discusses the potential public health impacts on various water users. Implementation of the LSJR alternatives may have some public health impact, with potential public health impacts increasing as the percent unimpaired flow[11] increases. Thus, as LSJR Alterative 2 would have the lowest percentage of unimpaired flow (at 20 percent), it would have the lowest impact on municipal and domestic water supplies, and therefore the least potential impact on public health. The risk of potential public health impacts would increase with LSJR Alternatives 3 and 4. However, because water supply conditions vary by service providers, and because service providers and end users would have varied responses to reduced surface water deliveries, the impacts of the LSJR alternatives on public health cannot be determined with certainty.

The following sections discuss potential public health impacts that specific water users could experience under the LSJR alternatives.

Municipalities and Public Water Systems

Under reduced surface water supply conditions, such as those associated with the LSJR alternatives, California's reliance on groundwater increases, which in turn increases groundwater pumping and lowers groundwater levels. In addition to potentially resulting in reduced groundwater levels, increasing pumping also raises the risk of groundwater contaminant transport and public supply wells going dry, both of which impact water supplies and pose a potential public health threat to public water systems. Contaminated groundwater requires additional treatment and could pose a threat for water systems that could not afford additional treatment to remove contaminants from groundwater prior to serving it to customers. Additionally, lowering groundwater levels may require suppliers to deepen existing wells or construct new wells to ensure adequate groundwater supplies, which could result in higher costs for ratepayers and consumers. As mentioned above, impacts on public health would vary by public water supplier, based on local groundwater contaminants, the system's reliance on groundwater, and groundwater resource management. However, while the LSJR alternatives could have public health impacts, public water systems are required to prepare for reduced water supply scenarios, including reducing or preventing public health impacts.

Disadvantaged Communities

Potential public health impacts associated with the LSJR alternatives are similar to those discussed under Municipalities and Public Water Systems. However, as highlighted during the recent drought, the effects of reduced surface water supplies are not felt by communities equally. In California,

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[10] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

[11] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

communities of color and low-income people living in tribal, rural, and farming communities often disproportionately experience impacts on drinking water supplies. While the public water systems serving DACs are still required to maintain essential public health and resources, public water systems serving DACs are less likely to have the resources to adequately respond to water supply or water quality emergencies.

As discussed above, responding to contaminated or reduced groundwater resources is expensive. The systems serving DACs are more likely to have a difficult time responding to impacts on their water supply because they lack the infrastructure and financing that exists for the water systems serving more affluent communities, which may make them unable to afford treating or finding alternative supplies for a contaminated drinking water source. As a result, DACs may be more vulnerable than other municipalities and cities to impacts associated with the LSJR alternatives.

Domestic Well Users

As discussed earlier in this chapter and in Chapter 9, *Groundwater Resources*, due to their shallower depths, domestic wells are more susceptible to the impacts associated with the LSJR alternatives—such as groundwater contaminant transfer and dry wells—than public water systems wells. Additionally, domestic well owners lack the resources of public water systems to respond to reduced drinking water supplies. Domestic well users represent a small percentage of water users within the four groundwater subbasins, which means that potential public health impacts are more likely to occur as isolated cases. However, given their limited resources, it is possible that individual users would experience more significant impacts than would be experienced by a public water system under the same supply reductions. Given the lack of data regarding both the exact number of domestic well users and the groundwater quality of domestic wells, it is not possible to assess the potential public health impacts on domestic well users.

Schools

With students typically spending at least six hours at school each day, ensuring safe, clean drinking water at schools is an important factor in contributing to overall good health. Like the other water users discussed above, public health impacts associated with the LSJR alternatives will vary by school. However, because schools receive water from either a public water system or a private well, the potential public health impacts would be similar to those impacts discussed in the sections above.

22.4.3 Costs of Potential Management Options

As discussed previously, service providers could respond to reduced surface water supplies associated with LSJR alternatives by deepening their wells and constructing more wells. Additionally, service providers could reduce overall water use by implementing water efficiency and conservation programs, create alternative water supplies through groundwater recharge programs and recycled water programs, or purchase water from other agencies. Domestic well owners might deepen their wells or construct new wells. This section describes potential actions affected entities could take to replace surface water that may be reduced due to implementing the LSJR alternatives. Such actions include the following.

- Substitute groundwater for surface water by deepening wells and constructing more wells – The costs of well projects can vary substantially depending on the geology of the well location, well depth and diameter, well type, pump efficiency, level of water treatment required, size of the distribution system, and cost of electricity and staff needed to maintain equipment and facilities. Table 22-6 shows the two well projects that were funded by the State Water Board. As shown in the table, the cost ranged widely among the projects. One of the dominant cost categories in the operations and maintenance budget for groundwater wells is the cost for electricity. Based on information presented in Chapter 16, *Evaluation of Other Indirect and Additional Actions,* it can reasonably be estimated that groundwater pumping electrical costs in the plan area are between \$57.36 and \$76.48/AF. According to Flex Your Power (2012), energy costs may represent 50–75 percent of a water utility's budget. Using the upper end electricity cost calculated above (\$76.48/AF), it can reasonably be estimated that annual total operations and maintenance cost of a groundwater project would be between \$101.97–\$152.96/AF.

- Purchase water from parties that have extra water through contracts or transfers – The duration and cost for purchasing water are subject to many factors. A short-term transfer is a transfer of 1 year or less; a long-term transfer is a transfer longer than 1 year. A water transfer may change the place of use, the point(s) of diversion, or the purpose of use. A water transfer cannot increase the amount of water a diverter is permitted to use, nor can it change the season when water is diverted. According to USBR (2006), average costs for a short-term water transfer is \$1,716/AF and \$310/AF for a long-term water transfer.
- Recharge groundwater basins – Recharging groundwater basins by storing "extra" available surface water in the aquifer allows it to be extracted for use later, when the water would otherwise be unavailable. This process is known as aquifer storage and recovery (ASR), which typically includes: (1) gravity recharge basins or injection wells that move water under pressure from the surface to an underground aquifer, and (2) wells that pump groundwater from the aquifer and send the water to an existing treatment plant or directly into a distribution system for use. The costs of ASR projects are highly variable and depend on many factors. Table 16-8 identifies recently funded groundwater recharge projects. Annual costs are typically between \$158 and \$238/AF; this includes planning, design, permitting, land acquisition/rights of way, construction, and administrative costs, in 2010 dollars (DWR 2012).
- Use recycled water – Recycled water is wastewater that has been treated to a desired water quality standard, and then distributed and used for another purpose. Typically, recycled water costs less than potable water because it does not need to meet the same water quality standards. For example, cities and municipalities could offset potable water by using recycled water to irrigate parks, golf courses, gardens and other landscaping areas, and agricultural fields. Thus more potable water could be made available for municipal uses. The complexity and cost of a recycled water project depends on many factors, such as the level of treatment needed, the desired water quality for the secondary beneficial use, and the distance between the treatment location and the use location. Recycling wastewater for landscape and agricultural irrigation typically costs between \$400-\$2,100/AF, including capital, treatment, operations, and maintenance costs (WRF 2011). With advanced treatment technology, recycled water could also be used to replace potable water for domestic use. Direct potable reuse is practiced in areas where supply water is extremely scarce, such as Singapore and Namibia (WRF 2011). Direct potable reuse of recycled water typically costs \$700–\$1,200/AF, including capital, treatment, operations, and maintenance (WRF 2011). Recycled water can be used by the commercial, institutional, or industrial sector as process water. For example, cooling towers at power plants could use recycled water to offset the need for potable water. Water quality required for process

water is similar to that for potable water. Process water recycling projects typically cost the same as direct potable reuse projects due to the need for higher water quality.

The cost of each of these options is summarized in Table 22-7. See Chapter 16, *Evaluation of Other Indirect and Additional Actions,* for more information on these potential substitution options.

Table 22-6. Example New Groundwater Well Projects Funded by the State

Applicant	Project	Construction Cost ($)	Production Capability (AFY)	Depth (ft)	Cost per foot of depth ($)
City of Ceres	Replacement of well due to uranium and nitrate contamination	155,598 [a]	1,936	324	480
Plainsburg Elementary School	New water supply well	165,000 [b]	242	600	275

Source: Orellana pers. comm.

[a] Well is equipped with a 100 horsepower submersible pump. It is unclear whether the cost of distribution pipelines is included.

[b] This cost includes the cost of the labor and equipment to drill and install well casing to 600 feet, installation of a submersible pump, pressure tank and electrical system, E-log, potholing for existing utilities, water for drilling, access to the job site as well as a survey.

Table 22-7. Costs of Potential Management Options

Option	Cost ($)
Deepen existing wells	Variable, range between $15–$50/foot
Construct new wells	Highly variable (Table 22-6) Operations and maintenance (O&M) annual costs range between $101.97–$152.96/AF
Purchase water from another party (short-term water transfer)	$1,716/AF on average
Purchase water from another party (long-term water transfer)	$310/AF on average
Treat recycled water	$400–$2,100/AF for irrigation including capital and O&M costs (WRF 2011) $700–$1,200/AF for direct portable reuse and process water, including capital and O&M costs (WRF 2011)
Aquifer storage and recovery (ASR) projects	Highly variable (see Table 16-8), depends on the scale of the project and the level of O&M required

Source: Chapter 16, *Evaluation of Other Indirect and Additional Actions*

22.5 Assistance Programs

Sustainable water supply solutions must strike a balance between the need to provide for public health and safety (e.g., safe drinking water, clean rivers and beaches, flood protection), protect the environment, and ensure a stable California economy. There are many state, county, and local assistance programs available that may be leveraged to support and improve water supplier planning and supply efforts. This section highlights select State Water Board programs that provide financial and technical assistance to agencies for implementing water supply and quality projects.

22.5.1 Financial Assistance

There are many state and federal financial assistance programs designed to assist public water systems. Over the last 15 years, four major state public funding sources have been made available for public drinking water or water quality improvement projects: Proposition 50, Proposition 84, the Drinking Water State Revolving Fund (DWSRF), and Proposition 1. Often, these funding programs leverage each other to make a project more feasible. A brief description of some applicable funding programs is included in Chapter 16, Section 16.5, *Sources of Funding*.

The State Water Board works with local, state, and federal partners to provide financial assistance to at-risk drinking water systems. This includes a broad range of funding sources for new wells, interties, and emergency drinking water supplies. Through propositions 50 and 84, the State Water Board has provided funding for projects intended to improve water security, as well as infrastructure improvement and groundwater quality projects, and emergency and urgent funding for projects that ensure safe drinking water supplies. The DWSRF continues to provide funding assistance to public water systems for infrastructure improvements to correct public water system deficiencies that pose public health risks and improve drinking water quality, or both.

The passing of Proposition 1 expanded upon existing funding programs, making an additional $260 million available for the DWSRF projects. Proposition 1 also provided $260 million to the Small Community Grant Fund to provide financial assistance to small communities (i.e., population of 20,000 persons, or less) for the planning, design, and construction of publicly owned wastewater treatment and collection facilities. Proposition 1 provided $800 million for projects intended to prevent and clean-up contamination of groundwater that serves (or has served) as a source of drinking water. Additionally, Proposition 1 provided $625 million for water recycling projects and $200 million for storm water projects that will improve regional water supply resiliency.

During the recent drought emergency, the State Water Board made $19 million in funding available to meet interim emergency drinking water needs for those communities, including DACs, with a contaminated water supply or that suffered drought-related water outages or threatened outages (State Water Board 2016). The State Water Board's Drought Response Outreach Program for Schools (DROPS) made $30.2 million in funding available to schools to encourage water conservation education and projects. DROPS provides grants to school districts to create opportunities for storm water retention and reuse, and to raise awareness of sustainability. All DROPS-funded projects include an educational and outreach element to increase student and public awareness of water conservation.

Many financial assistance programs include additional assistance for eligible DACs. During the recent drought, many county and non-profit programs have provided financial assistance to communities with impacted drinking water supplies.

22.5.2 Technical Assistance

Complying with state and federal drinking water regulations is essential for protecting public health and ensuring safe drinking water. There are many technical assistance programs designed to assist agencies implementing water supply and water quality projects. These programs are designed to ensure access to a safe, clean, and affordable water supplies and maintain compliance with all applicable water laws and regulation. The State is committed to identifying and monitoring the status of drought-vulnerable public water systems to help prevent or mitigate any anticipated shortfalls in supply and to secure alternative sources of water for the communities when needed. In 2013, the State Water Board released a report that identified communities relying on a contaminated groundwater source for drinking water (State Water Board 2013). The state also works with local governments and agencies to identify drought-vulnerable areas served by domestic wells and collaborate to prevent or mitigate any anticipated shortfalls.

The State Water Board provides technical assistance to DACs and at-risk drinking water systems and works with the water systems to identify potential solutions. State technical assistance programs provide help with: preparing financial assistance applications; performing compliance audits; reviewing proposed projects alternatives; planning and preparing budgets; and performing community outreach, awareness, and education. DWSRF and Proposition 1 eligible projects can assist publicly owned water systems (e.g., counties, cities, districts), privately owned community water systems (e.g., for-profit water utilities, non-profit mutual water companies), and non-profit or publicly owned non-community water systems (e.g., public school districts) with the planning/design and construction of drinking water infrastructure projects that will improve the community's water efficiency and ensure a drought-resilient water supply. Potential solutions include, but are not limited to, stringent conservation measures, interconnections with other water systems (i.e., consolidation), development of new water sources, expansion of existing sources (e.g., deepen wells, extend reservoir intakes), and treatment of sources that produce water that does not meeting drinking water quality standards. Locally-implemented cost-effective and technically feasible strategies such as urban and agricultural water conservation and efficiency, water reuse and recycling, and storm water capture. Triggers and responses are developed and implemented at the local level.

Sometimes, the best solution for ensuring a safe drinking water supply is for a small, failing water system to join a larger public water system. Senate Bill (SB) 88 authorizes the State Water Board to require public water systems that consistently fail to meet standards to consolidate with, or obtain service from, a public water system. Consolidating public water systems and extending service from existing public water systems to communities and areas which currently rely on under-performing or small, failing water systems, as well as domestic wells, reduces costs and improves reliability (State Water Board 2015).

During the recent drought, many county and non-profit programs have provided technical assistance to communities and private well owners with impacted drinking water supplies, including providing free water quality testing for domestic wells.

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Orellana, Lucio. Water Resources Control Engineer. State Water Resources Control Board. Division of Financial Assistance, Sacramento, CA. April 28, 2016 —email re: Need assistance with well cost estimates. Sahota, Bhupinder S. Stockton District Engineer. State Water Resources Control Board, Division of Drinking Water, Stockton, CA. December 18, 2015 —email re: information request on active groundwater well information for SEWD.

Chapter 23
Antidegradation Analysis

23.1 Overview of Antidegradation Policies

The State Water Board and the United States Environmental Protection Agency (USEPA) have adopted antidegradation policies intended to protect existing high quality waters. Both the state and federal antidegradation policies, which are independently enforceable, require the high quality of these waters to be maintained unless otherwise provided by the policies.[1]

In 1968 the State Water Board adopted California's antidegradation policy by Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California." The state policy applies to surface water and groundwater whose quality meets or exceeds water quality objectives and establishes the intent to maintain high quality waters of the State to the maximum extent possible.

Whenever existing water quality is better than the quality established in applicable policies or plans, Resolution 68-16 provides that the high water quality must be maintained unless it can be demonstrated that any change in water quality will have the following results.

1. Will be consistent with the maximum benefit to the people of the State.
2. Will not unreasonably affect present and anticipated beneficial uses of such water.
3. Will not result in water quality less than that prescribed in applicable water quality control policies or plans.

Further, any activity that results in a discharge to high quality waters must use the best practicable treatment or control necessary to avoid a pollution or nuisance and to maintain the highest water quality consistent with the maximum benefit to the people of the state.

The federal antidegradation policy was included USEPA's first water quality standards regulation in 1975[2] (See 40 Fed. Reg. 55340-41, November 28, 1975). The federal antidegradation policy applies to surface water, regardless of the quality of the water. (40 C.F.R. § 131.12) Under the federal policy, "existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." (40 C.F.R. § 131.12, subd. (a)(1)) In addition, where the quality of waters exceeds levels necessary to support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality of water must be maintained and protected unless the state finds that

1. allowing lower quality is necessary to accommodate important economic or social development in the area in which the waters are located;

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[1] While the consideration of state and federal antidegradation policies is included as a chapter in this recirculated substitute environmental document (SED), it is not a requirement under CEQA.

[2] The federal antidegradation policy was originally based on the Clean Water Act's objectives, including the objective to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (33 U.S.C. § 1251(a)) In 1987, the Clean Water Act was amended to expressly require satisfaction of antidegradation requirements for revisions of certain effluent limitations. (33 U.S.C. § 1313(d)(4)(B))

2. water quality is adequate to protect existing beneficial uses fully; and
3. the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control are achieved. (40 C.F.R. § 131.12, subd. (a)(2))

The federal regulations further require that if a state determines it is necessary to lower the water quality of high quality waters, this determination will be based on both an analysis of alternatives that would lessen or prevent degradation and an analysis related to economic or social development in the area in which the waters are located. (40 C.F.R. § 131.12, subd. (a)(2)(ii); 80 Fed. Reg. 51032 (August 21, 2015)) However, the federal policy applies to reductions in water quality after the policy was adopted in November, 1975 (State Water Board 1994). The federal regulations also require that state water quality standards[3] include an antidegradation policy consistent with the federal policy. (40 C.F.R. § 131.12, subd. (a)) The State Water Board has interpreted Resolution 68-16 to incorporate the federal policy where the federal policy applies under federal law[4] (State Water Board 1986; State Water Board 1994).

The proposed amendments to the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (2006 Bay-Delta Plan) will fully protect existing beneficial uses and will not result in a lowering of water quality. Instead, the analysis of the proposed plan amendments[5] indicates it will likely result in water quality improvements in the San Joaquin River (SJR) Watershed and the southern Delta. As such, a complete antidegradation analysis is not required. (See, e.g., State Water Board, Administrative Procedures Update, Antidegradation Policy Implementation for NPDES Permitting, 90-004 (State Water Board 1990) Nonetheless, by raising the salinity water quality objective in the Southern Delta, the proposed plan amendments may appear to relax the objective and authorize a lowering of water quality. Accordingly, the State Water Board provides the analysis in this chapter, with respect to salinity, to show how existing uses will be fully protected and how water quality will be maintained or improved, consistent with the principles contained in the state and federal antidegradation policies, under the proposed Bay-Delta Plan amendments. In addition, the following analysis demonstrates how there will not be a lowering of water quality with respect to other affected parameters. The analyses are based on available water quality data, modeling, and other analyses contained elsewhere in the recirculated substitute environmental document (SED).

23.2 The 2006 Bay-Delta Plan

The 2006 Bay-Delta Plan defines beneficial uses of water and establishes water quality objectives to reasonably protect these beneficial uses. The plan also includes a program of implementation to achieve the objectives. The requirements of the 2006 Bay-Delta Plan are primarily implemented

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[3] Together, the beneficial uses and the water quality objectives established to reasonably protect the beneficial uses are called water quality standards under the terminology of the federal Clean Water Act.

[4] The State Water Board continues to reserve its arguments regarding the USEPA's authority to adopt standards for flow and operations, including standards for salinity intrusion. (See Bay-Delta Water Quality Control Plan, footnote 3.) To the extent the proposed flow and salinity water quality objectives are state-only standards, the federal antidegradation policy would not apply.

[5] These plan amendments are the *project* as defined in State CEQA Guidelines, Section 15378.

through water right actions and other measures, such as Clean Water Act hydropower water quality certifications. The beneficial uses protected by the 2006 Bay-Delta Plan include the following.

- Agricultural supply (AGR)
- Cold freshwater habitat (COLD)
- Commercial and sport fishing (COMM)
- Contact water recreation (REC-1)
- Estuarine habitat (EST)
- Groundwater recharge (GWR)
- Industrial process supply (PRO)
- Industrial service supply (IND)
- Migration of aquatic organisms (MIGR)
- Municipal and domestic supply (MUN)
- Navigation (NAV)
- Non-contact water recreation (REC-2)
- Rare, threatened, or endangered species (RARE)
- Shellfish harvesting (SHELL)
- Spawning, reproduction, and/or early development (SPWN)
- Warm freshwater habitat (WARM)
- Wildlife habitat (WILD)

23.3 San Joaquin River Water Quality Objectives for Fish and Wildlife Beneficial Uses

23.3.1 Current San Joaquin River Flow Objectives

The State Water Board first established the SJR flow objectives at Vernalis to protect fish and wildlife beneficial uses in the 1995 Bay-Delta Plan. The State Water Board set different flow objectives for three time periods: February through June, excluding April 15 through May 15 (spring flows); April 15 through May 15 (pulse flows); and October (fall flows). The flow objectives vary depending on the water year type, with higher flows required in wetter years. The spring flow objective was intended to provide minimum freshwater flows in the SJR to address habitat concerns caused by reduced tributary inflows and poor water quality. The pulse flows were principally developed to aid in cueing fall-run Chinook salmon juvenile out-migration in the spring from the SJR. The fall flows were developed to provide attraction flows for fall-run adult salmon returning to the watershed to spawn. The objectives were based on the limited scientific information available at the time. To obtain additional scientific information, the State Water Board in Revised Decision 1641 (2000) approved conducting the Vernalis Adaptive Management Plan (VAMP) experiment proposed in the San Joaquin River Agreement (SJRA) until 2012, in lieu of meeting the pulse flow objectives included in the 1995

Bay-Delta Plan. In 2006, the Bay-Delta Plan was amended to allow the VAMP experiment to be conducted in lieu of the pulse flows.

23.3.2 Proposed Lower SJR Flow Objectives

The proposed Lower San Joaquin River (LSJR) flow objectives would replace the existing water quality objectives for fish and wildlife beneficial uses at Vernalis during the February–June time frame. The proposed objectives call for inflow conditions from the SJR Watershed to the Delta at Vernalis sufficient to support and maintain the natural production of viable native fish populations migrating through the Delta. Inflow conditions include those that more closely mimic the natural hydrographic conditions to which native fish species are adapted, including the relative magnitude, duration, timing, and spatial extent of flows as they would naturally occur. Indicators of fish population viability include abundance, spatial extent, distribution, structure, genetic and life history diversity, and productivity. In addition to the narrative objective, the flow objectives will require from each of the three eastside tributaries to the LSJR, the Merced, Tuolumne, and Stanislaus Rivers, to release a percent of unimpaired flow[6] to the LSJR. The flow objectives evaluated in this SED and this chapter range from 20 percent to 60 percent of the unimpaired flow on each tributary. In addition, a minimum base flow value between 800–1,200 cubic feet per second (cfs), based on a maximum 7-day running average, will be required at Vernalis from February–June.

As described in Appendix K, *Revised Water Quality Control Plan*, the program of implementation will allow the unimpaired flow objective to be adjusted, or adaptively implemented. Specifically, the flow objectives may be adjusted if information produced through the monitoring and review processes, as described in Appendix K, or other best available scientific information indicates that such changes will be sufficient to support and maintain the natural production of viable native SJR Watershed fish populations migrating through the Delta and meet any existing biological goals approved by the State Water Board. Adaptive implementation options include: (1) adjusting the percentage of unimpaired flow within an adaptive range (30 to 50 percent for LSJR Alternative 3), (2) managing the required percentage of unimpaired flow as a total volume that may be released on an adaptive schedule during the February–June period, and (3) shifting flow from the February–June period for release later in the year to prevent adverse impacts on coldwater pool and related fisheries impacts. These measures would be implemented based on real-time circumstances and available scientific information to achieve the narrative objective for the protection of LSJR fish and wildlife. The Vernalis base flow objective may also be adaptively implemented within the allowed range of 800–1200 cfs.

Appendix K describes the coordination actions and approvals needed to manage the flows from the tributaries to the LSJR. This includes the creation of a Stanislaus, Tuolumne, and Merced Working Group (STM Working Group) whose purpose is to assist with implementation, monitoring and effectiveness assessment activities for the LSJR flow objectives. The State Water Board will seek recommendations from the STM Working Group on biological goals to inform adaptive implementation actions and the effectiveness of the program of implementation, among others.

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[6] *Unimpaired flow* represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. It differs from natural flow because unimpaired flow is the flow that occurs at a specific location under the current configuration of channels, levees, floodplain, wetlands, deforestation and urbanization.

23.4 Southern Delta Salinity Water Quality Objectives to Protect Agricultural Beneficial Uses

23.4.1 Current Southern Delta Salinity Objectives

The current salinity objectives for agricultural beneficial uses in the southern Delta are found in Table 2 of the 2006 Bay-Delta Plan (and shown below in Table 23-1). The salinity objectives apply in all water year types and compliance is determined at the following four locations: (1) SJR at Airport Way Bridge, Vernalis (Station C-10); (2) SJR at Brandt Bridge (Station C-6); (3) Old River near Middle River (Station C-8); and (4) Old River at Tracy Road Bridge (Station P-12)[7]. While the salinity objectives for the southern Delta apply to all locations in the general area, these specific locations are used to determine compliance with the objectives.

Table 23-1. Current South Delta EC[8] Standards

EC Objective (30-day running average)	Time Period
0.7 dS/m EC (mmhos/cm)[9]	April 1–August 31
1.0 dS/m EC (mmhos/cm)	September 1–March 31

dS/m = deciSiemens per meter
mmhos/cm = millimhos per centimeter

Agricultural beneficial use is the most sensitive use requiring protection for the range of salinity conditions encountered in the southern Delta. The current salinity standards for the southern Delta were originally adopted in the 1978 *Water Quality Control Plan for the Sacramento-San Joaquin Delta* (1978 Bay-Delta Plan) to protect agricultural beneficial uses. These standards were based on the water quality needs of the different crops grown, predominant soil types, and irrigation practices in the southern Delta. The salinity objectives did not take immediate effect, but instead were to become effective on completion of suitable circulation and water supply facilities. In addition, a year-round total dissolved solids (TDS)[10] standard of 500 milligrams per liter (mg/L) (equivalent to approximately 0.83 dS/m EC) at Vernalis was also included in the 1978 Delta Plan, which became effective in 1980 when New Melones Dam was completed. Prior to adoption of the 1978 Bay-Delta Plan, the Central Valley Regional Water Quality Control Board adopted in its June 1971 *Interim Water Quality Control Plan, San Joaquin River Basin 5C*, a TDS standard of 500 mg/L as a maximum 30-day running average at Vernalis. Water Right Decision 1422 adopted by the State Water Board in 1973, which addressed the U.S. Bureau of Reclamation's (USBR) application to appropriate water from the

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[7] Although the 2006 Bay-Delta plan identifies this compliance station as Tracy Road Bridge, the actual location is Tracy Boulevard Bridge, consequently Tracy Blvd. will be used here for accuracy.

[8] In this document, EC is *electrical conductivity,* which is generally expressed in deciSiemens per meter (dS/m). Measurement of EC is a widely accepted indirect method to determine the salinity of water, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). EC and salinity are therefore used interchangeably in this document.

[9] The text in this chapter and elsewhere in this SED primarily describes salinity using deciSiemens per meter (dS/m), while the units of millimhos/cm (mmhos /cm) are used in the 2006 Bay-Delta Plan. These units are interchangeable in that EC equivalent to 1.0 mmhos/cm is the same as an EC of 1.0 dS/m.

[10] Total dissolved solids is another way to measure dissolved salts in water that has been replaced by electrical conductivity (EC) due to the relative ease in measuring EC.

Stanislaus River, assigned responsibility to USBR for meeting the 500 mg/L TDS salinity standard at Vernalis.

Updates to the Bay-Delta Plan in 1991 and 1995 did not substantively change the southern Delta salinity objectives, except for removal of the 500 mg/L TDS standard at Vernalis beginning with the 1991 plan. Both plans again provided for the staged implementation of the EC water quality objectives. The 1991 Bay-Delta Plan required implementation of the Vernalis and Brandt Bridge salinity standards by 1994, while the Old River near Middle River and Old River at Tracy Boulevard were to be implemented by 1996. Water Right Order 95-6, adopted by the State Water Board in 1995, assigned to USBR the responsibility for meeting the April–August 0.7 dS/m and the September–March 1.0 dS/m EC salinity objectives at Vernalis, which replaced USBR's previous requirement to meet the 500 mg/L TDS standard at Vernalis. Water Right Order 95-6 did not assign responsibility to meet the salinity standards at the other three compliance stations. The 1995 Bay-Delta Plan delayed the compliance date of the agricultural salinity objectives at Old River near Middle River and Old River at Tracy Boulevard from 1996 to December 31, 1997.

In 2000, the State Water Board adopted a water right decision (Revised Decision 1641) that assigned responsibility for meeting the southern Delta salinity objectives by amending the California Department of Water Resources' (DWR) State Water Project (SWP) water rights and the USBR's Central Valley Project (CVP) water rights to require compliance with the 1995 Bay-Delta Plan salinity objectives. In Revised Decision 1641, the State Water Board, however, further delayed the effectiveness of the 0.7 dS/m EC water quality objective set forth in the 1995 Bay-Delta Plan at the Brandt Bridge and the two Old River compliance locations until April 2005. It also allowed for the 0.7 dS/m EC objective to be replaced by the 1.0 dS/m EC objective after April 1, 2005, if permanent barriers were constructed, or equivalent measures were implemented, in the southern Delta and an operations plan that reasonably protected Delta agriculture was prepared by USBR and DWR and approved by the State Water Board Executive Director. In 2006, the Court of Appeals held that the State Water Board did not adequately implement the 1995 Bay-Delta Plan because the plan did not allow further delay in the implementation of the 0.7 dS/m EC water quality objective at the three compliance locations or replace the 0.7 EC objective with the 1.0 EC objective. (State Water Board Cases (2006) 136 Cal.App.4th 674–735 (39 Cal. Rptr. 3d 189)) Currently, SWP and CVP water rights are conditioned on implementation of the EC objectives at the three southern Delta stations downstream of Vernalis and the CVP permits under which USBR delivers water to the SJR Basin are conditioned on meeting the salinity objectives in the SJR at Vernalis.

23.4.2 Proposed Southern Delta Salinity Objectives

The proposed amendments to the Bay-Delta Plan will establish a year-round salinity objective to protect agricultural beneficial uses in the southern Delta of 1.0 dS/m as a maximum 30-day running average of mean daily EC to replace the current seasonal objective of 0.7 dS/m from April–August. The September–March 1.0 dS/m water quality objective will remain unchanged. The compliance locations will include (1) the SJR at Airport Way Bridge, Vernalis; (2) the SJR from Vernalis to Brandt Bridge: (3) Middle River from Old River to Victoria Canal; and (4) Old River/Grant Line Canal from the Head of Old River to West Canal. The program of implementation requires the development of a monitoring plan to assess compliance with the proposed salinity objective, which may lead to changes in the specific locations where compliance is determined. Until the plan is developed, compliance will be assessed at the four locations contained in the 2006 Bay-Delta Plan.

The proposed change to the salinity objective to protect agricultural beneficial uses is based on scientific information and analysis described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and contained in Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*. Appendix E examines current agricultural practices, soil characteristics, and crop patterns in the southern Delta to perform its analysis. The analysis in Appendix E concludes that the proposed 1.0 dS/cm EC objective provides for 100 percent yields under most hydrological conditions, and 95 percent yields for the most salt-sensitive crop grown in the region (i.e., dry beans) under dry year conditions and, therefore, adequately protects agricultural beneficial use in the southern Delta. Consequently, the existing April – August water quality objective of 0.7 dS/m, which has never been consistently achieved at all of the required locations, is over protective.

To meet the revised salinity objective downstream of Vernalis, the proposed program of implementation will require the continued conditioning of USBR's water rights pursuant to Revised Water Right Decision 1641. Specifically, USBR's water rights will continue to require the USBR to meet salinity levels of 0.7 dS/m at Vernalis from April 1–to August 31 and 1.0 dS/m from September 1–March 31, as has been the condition since State Water Board adoption of Water Right Order 95-6 in 1995. This will provide assimilative capacity for salinity inputs downstream of Vernalis and help maintain salinity levels that meet the revised objective and reasonably protect agricultural beneficial uses in the southern Delta. Continuation of this requirement will assure that the proposed change to the salinity objective will not result in the lowering of water quality at and downstream of Vernalis in the southern Delta.

The proposed program of implementation requires that DWR and USBR develop and implement a comprehensive operations plan to address the impacts of SWP and CVP export operations on flow and salinity conditions in the southern Delta, including the availability of assimilative capacity for local sources of salinity. DWR's and USBR's water rights will be conditioned to required continued operations of the agricultural barriers at Grant Line Canal, Middle River, and Old River at Tracy Boulevard, or other reasonable measures, to address the impacts of the export operations. In addition, DWR's and USBR's water rights would be conditioned to require monitoring, modeling, special studies, and reporting activities, in coordination with other monitoring programs, to ensure that the salinity objectives are effectively implemented. The proposed program of implementation also includes recommendations to other agencies that would assist in meeting the southern Delta salinity objective (Appendix K, *Revised Water Quality Control Plan*).

23.5 Antidegradation Analysis

The proposed changes to the LSJR flow objectives and southern Delta salinity objective in the Bay-Delta Plan would not result in a lowering of water quality in the Stanislaus, Tuolumne, and Merced Rivers, the LSJR, and the southern Delta. As such, a complete antidegradation analysis is not required (State Water Board 1990). The State Water Board, nevertheless, provides one for salinity because raising the April–August 0.7 dS/m salinity water quality objective to 1.0 dS/m may appear to allow water quality degradation. In addition, the analysis below explains why there will not be a lowering of water quality with respect to other parameters. The analysis evaluates the State Water Board's preferred alternatives: Southern Delta Water Quality (SDWQ) Alternative 2 (1.0 dS/m EC as a running 30-day average year-round) and LSJR Alternative 3 (40 percent unimpaired flow with adaptive implementation); however, this analysis also considers unimpaired flows ranging from 20 percent to

60 percent in order to evaluate a broad range of the LSJR flow objectives alternatives on water quality.

23.5.1 Salinity

Although many factors influence water quality, the new LSJR flow objectives proposed as part of the updated Bay-Delta Plan could affect salinity concentrations in the southern Delta. Salinity, therefore, is evaluated under varying flow objectives (the LSJR alternatives) proposed to revise the Bay Delta Plan. This analysis uses modeling results from the Water Supply Effects (WSE) model to examine whether the proposed changes to the southern Delta salinity and flow objectives for the LSJR would result in a lowering of water quality. Appendix F1, *Hydrologic and Water Quality Modeling*, and Chapter 5, *Surface Hydrology and Water Quality*, of this SED provide explanation and details regarding the analyses and models used to assess the impacts of the proposed plan amendments on water quality. Chapter 5 also evaluates whether the LSJR and SDWQ alternatives would degrade water quality by increasing salinity concentrations at Vernalis or elsewhere in the southern Delta, such that agricultural beneficial uses are impaired. The analysis in Chapter 5 concludes that all LSJR alternatives would reduce average EC values at Vernalis and in the southern Delta channels from April–September and maintain agricultural beneficial uses.

Historical Conditions and Factors Affecting Salinity

Salinity patterns in the southern Delta began to change from their natural state early in the Twentieth Century as a result of increasing agricultural diversions in and around the Delta. Salinity conditions were further altered by the completion of the state, federal, and local water projects, which together have reduced flow entering the Delta at Vernalis. Historical water quality in the southern Delta is discussed in Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*. Appendix F.2 also describes the high annual and seasonal variability of southern Delta salinity and the strong correlation between salinity and streamflow at Vernalis.

Salinity levels in the southern Delta are affected primarily by the salinity of water flowing into the southern Delta from the SJR near Vernalis and evapoconcentration of salt in water that is diverted from and discharged back into southern Delta channels for agricultural purposes. Point sources of salt in the southern Delta have a small overall salinity effect. High Vernalis flows generally reduce the salinity of water entering the southern Delta from the SJR by diluting salt loads from upstream areas. Municipal treated wastewater discharges[11] have a relatively small effect on the southern Delta salinity. Higher CVP and SWP pumping also has an effect on southern Delta salinity by bringing more low-salinity Sacramento River water across the Delta to the export pumps. In addition, periods of low Delta outflow (in the fall months) can cause increased seawater intrusion and higher EC at the southern Delta export facility and Contra Costa Water District intakes.

In the early 1970s, salinity conditions at Vernalis did not always meet water quality standards for salinity, as evident in the discussion provided in Water Right Decision 1422, issued in 1973. Water Right Decision 1422 states that the water quality objective of 500 mg/L TDS (~0.83 dS/m EC) was

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[11] Municipal dischargers in the southern Delta are currently not subject to the existing numeric salinity water quality objectives in the 2006 Bay-Delta Plan as a result of a superior court decision in *City of Tracy v. California State Water Resources Control Board*, Sacramento Superior Court, Case No. 34-2009-80000392. In order for municipal dischargers to be subject to salinity standards, the decision requires the consideration of Water Code section 13241 factors for any new salinity standards and a program of implementation.

exceeded 38 percent of the time during the irrigation season. After adoption of the first salinity objectives at Vernalis in the June 1971 Interim Water Quality Control Plan, San Joaquin River Basin 5C, the LSJR was identified as impaired due to salinity in 1975 (1975 303[d] list). Implementation of the April–August 0.7 dS/m salinity objective for the southern Delta, first adopted in the 1978 Bay-Delta Plan, was delayed repeatedly under the assumption that infrastructure would be built to better meet the objective; however, these actions never occurred. Salinity conditions did not improve in the 1980s or early 1990s, as indicated by historical water quality data presented in the final environmental impact report to support implementation of the 1995 Bay-Delta Plan, which shows that the April–August 0.7 dS/m salinity objective at Vernalis was exceeded 62 percent of the time between 1986 and 1995 (State Water Board 1999).

Salinity conditions improved after 1995 when Water Right Order 95-6 assigned USBR responsibility to meet the Vernalis salinity objectives of 0.7 dS/m EC from April–August and 1.0 dS/m EC from September–March. In addition, regulatory requirements for discharge of agricultural drainage upstream of Vernalis were put in place in 1996, in particular for the Grasslands drainage area, which have helped reduce the salinity load and improved water quality in the LSJR. As of 2015, the salinity discharges from the Grasslands drainage area have been reduced by 83 percent between 1995 and 2015 (SLDMWA 2015).

There is a strong relationship between EC values at Vernalis and EC at downstream monitoring locations under most flow regimes. Therefore, as conditions at Vernalis have improved since 1995, so have conditions at the other southern Delta salinity compliance stations. However, despite the improvement, compliance with the interior southern Delta salinity objectives has not always been achieved. The standards at the interior south Delta stations are more difficult to achieve because of high salinity runoff from agricultural land downstream of Vernalis. There are also additional sources of salinity between Vernalis and the other locations, as well as diversions and other hydrodynamic factors that may increase salinity concentrations at the interior locations compared to Vernalis.

Figure 23-1 is an exceedance chart of observed monthly average EC values collected for April–August from 1995–2015 at the four southern Delta compliance locations (Old River at Tracy Boulevard Bridge, Old River near Middle River, SJR at Vernalis, and SJR at Brandt Bridge). Figure 23-1 shows the percent of months during the irrigation season that the monthly average EC values exceeded the 0.7 dS/m EC standard for each of the southern Delta stations. From 1995 to 2015, the monthly average EC at Vernalis exceeded 0.7 dS/m EC only once during April–August, just barely in July of 2015. However, for the other three locations, the average monthly EC exceeded 0.7 dS/m more frequently over the last 2 decades. For the SJR at Brandt Bridge and the Old River near Middle River locations, the average monthly EC remained below 0.7 dS/m approximately 85 percent and 83 percent of months, respectively. Conditions for Old River at Tracy Boulevard Bridge are often worse than the other stations, and the average monthly EC remained below 0.7 dS/m only about 55 percent of the time (DWR 2016a, 2016b).

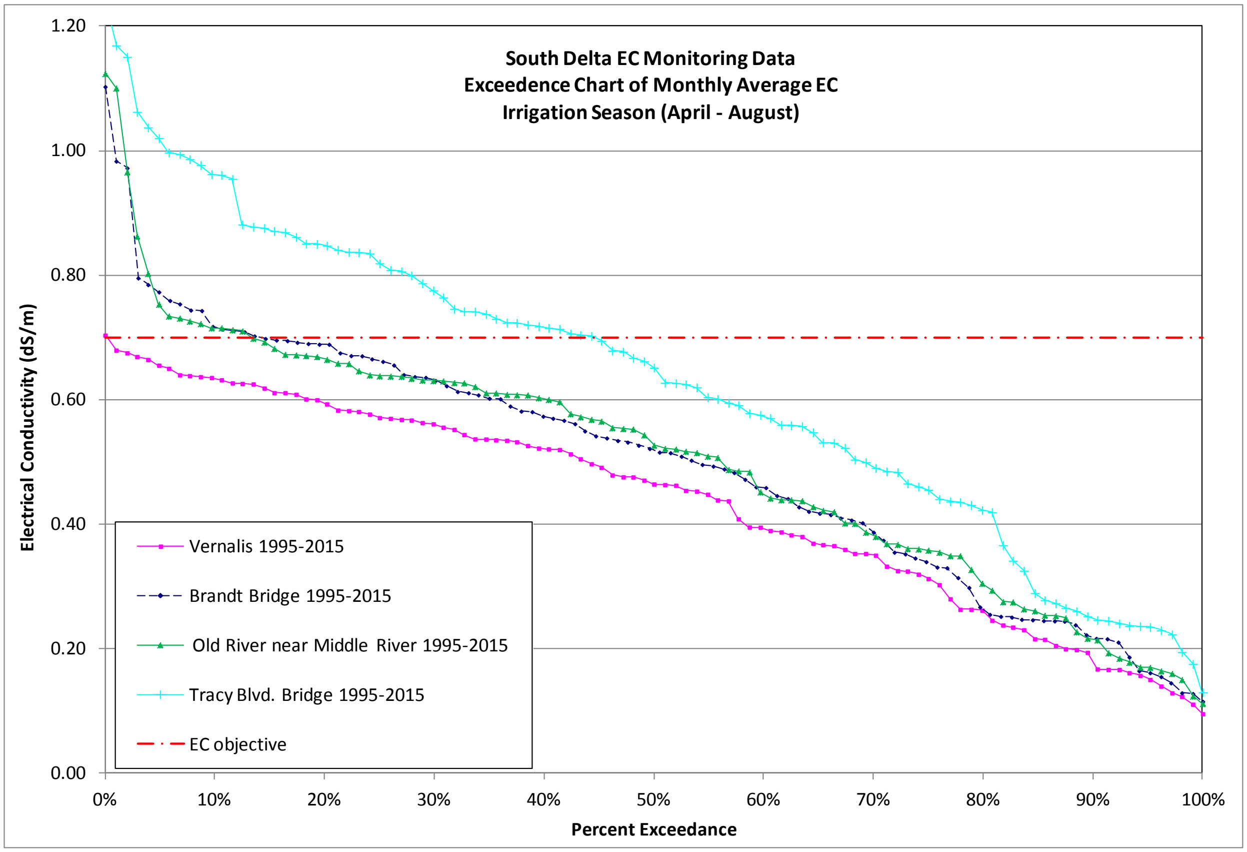

Figure 23-1. Exceedance Chart of Monthly Average EC (dS/m = deciSiemens per meter) Values at South Delta Monitoring Locations for Irrigation Months from 1995–2015

Figure 23-2 shows an exceedance chart for observed monthly average EC values collected for September–March from 1995–2015 at the four southern Delta compliance locations. Similar to Figure 23-1, this chart indicates the percent of months outside of the irrigation season that the monthly average EC values exceeded the 1.0 dS/m EC standard for each of the southern Delta stations. From 1995–2015 the monthly average EC at Vernalis never exceeded 1.0 dS/m from September–March. For the SJR at Brandt Bridge and the Old River near Middle River locations, the average monthly EC remained below 1.0 dS/m approximately 97 percent and 95 percent of months, respectively. Finally, The EC for Old River at Tracy Boulevard Bridge is less than 1.0 dS/m about 85 percent of the time.

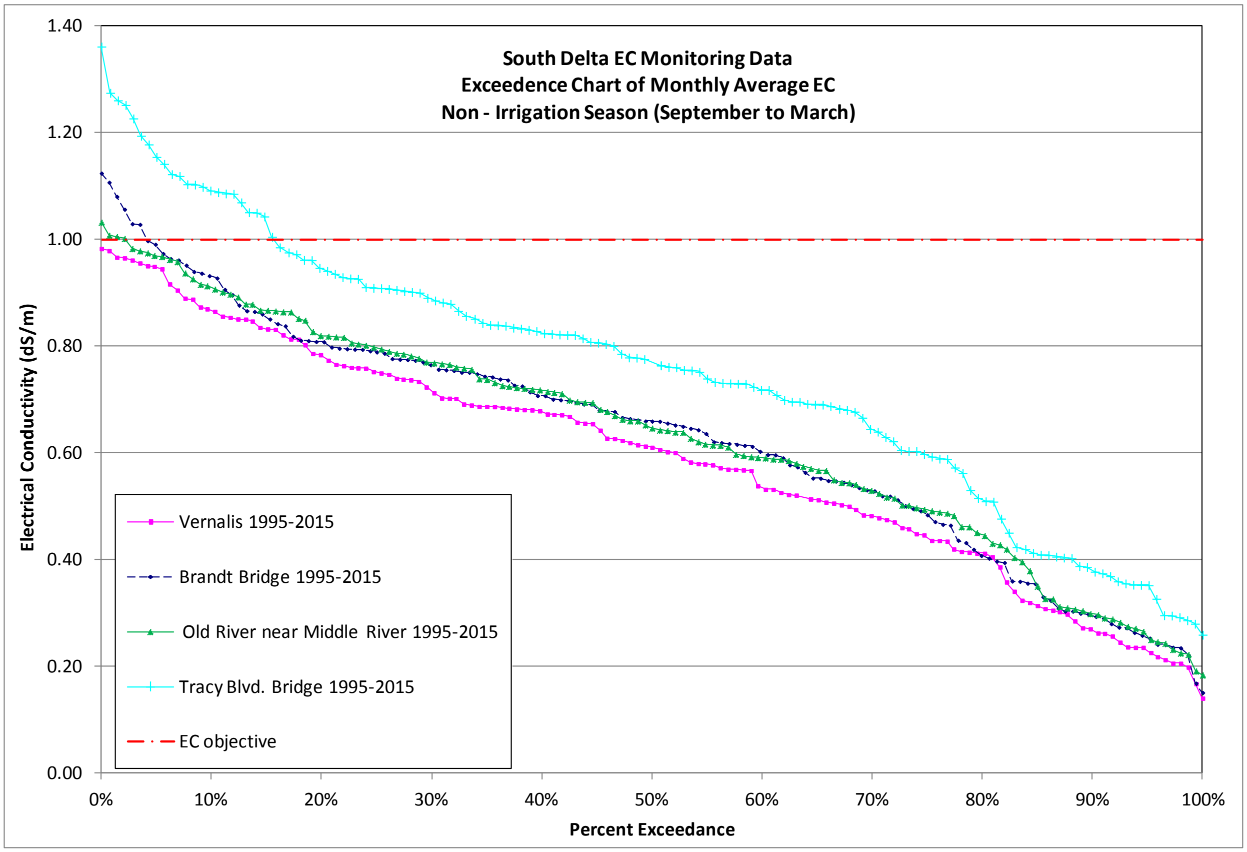

Figure 23-2. Exceedance Chart of Monthly Average EC (dS/m = deciSiemens per meter) Values at South Delta Monitoring Locations for Non-Irrigation Months from 1995–2015

Baseline Water Quality

Establishing the baseline receiving water quality for salinity determines the level of water quality protection. Baseline water quality for the purposes of the antidegradation analysis is the best quality of water measured since 1968, considering the state antidegradation policy, or 1975, considering the federal antidegradation policy, unless a subsequent lowering of water quality was allowed consistent with state and federal antidegradation policies. Under the state antidegradation policy, where a water quality objective for a particular constituent was adopted after 1968, the baseline for that constituent is the highest water quality achieved since the adoption of objective (Resolution 68-16, Resolve 1). If the baseline water quality is equal or less than the water quality objective, it must be maintained at the objective or improved to a level that achieves the objective (State Water Board 1990). If the baseline water quality is better than the water quality objective, it must be maintained unless poorer water quality is necessary to accommodate important economic or social development and is considered to be the maximum benefit to the people of the State (State Water Board 1990).Based on information and salinity data described above, 1995–2015 represents the period of highest water quality, with respect to salinity, since adoption of the state and federal antidegradation policies and establishment of the first salinity objectives. Therefore, this period represents the baseline water quality for salinity.

Salinity concentrations in the southern Delta vary widely over months and years, driven largely by changes in hydrology. The baseline water quality that is representative of salinity conditions must therefore be assessed based on a sufficiently long time frame that takes into consideration this variability. The historical variation in salinity and its relation to hydrological conditions is illustrated in Figure 23-3, which compares the monthly averages of EC and flow at Vernalis from 1995–2015 (DWR 2016b). This time period represents water quality conditions for a range of wet and dry water years. Using a 20-year baseline period is consistent with State Water Board guidance that baseline water quality should be representative of the water body, accounting for temporal and spatial variability (State Water Board 1990). Therefore, the 1995–2015 time period is appropriate for this antidegradation analysis.

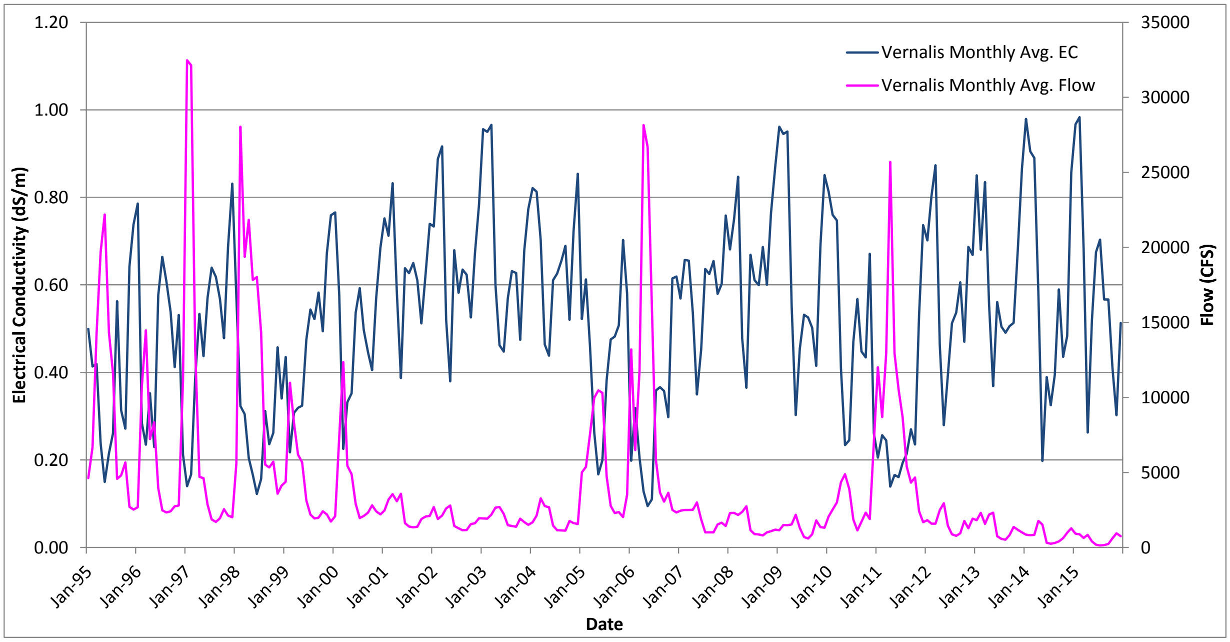

Figure 23-3. Monthly Average EC (dS/m = deciSiemens per meter) Observed at Vernalis Compared to Monthly Average Flow (cfs = cubic feet per second) Observed at Vernalis from 1995– 2015

Comparing the receiving water quality during the 1995–2015 baseline period to the existing water quality objectives (Figures 23-1 and 23-2) indicates that at Vernalis, the baseline water quality is equal to or better than the objective; at the other southern Delta locations, the baseline water quality is equal to or less than the existing objective. Where the baseline water quality is equal or less than the water quality objective, the water quality must be maintained or improved to a level that achieves the objective (State Water Board 1990). Where the baseline water quality is better than the water quality objective, the baseline water quality must be maintained unless poorer water quality is necessary to accommodate important economic or social development and is considered to be the maximum benefit to the people of the State. (State Water Board 1990) The analysis below explains why the baseline water quality will be maintained or improved under the proposed salinity objectives.

Analytic Approach

The WSE model results must be compared to the baseline water quality conditions before they can be used to make determinations about potential changes in salinity conditions. Though the WSE model simulates water operations using historical hydrology, operations are based on current infrastructure development and regulations. WSE model results, therefore, may be different than historical conditions. In addition, the modeling period used in the WSE model does not match the period observed to have the best water quality (i.e., the baseline water quality period). The WSE model uses the same modeling period as the CALSIM II model, water years from 1922–2003, which provides a robust representation of the varying conditions that have occurred in the SJR Watershed. There is only a relatively short period of time overlapping between the period of highest baseline water quality and the modeling results, 1995–2003, and this period is too short to adequately represent long-term variations in water quality.

To determine if modeled results for the LSJR alternatives show degradation in water quality, they must be compared to the model baseline. The *model baseline* represents the water infrastructure and regulatory conditions as of 2010. Due to operations to meet only the Vernalis salinity objective, periodic exceedances of interior southern Delta salinity objectives occur in the historical record and likewise remain in the modeled baseline conditions. A comparison of EC results for the LSJR alternatives and the model baseline will, therefore, show if the proposed flow objectives could cause an increase or decrease in EC at Vernalis and the interior southern Delta compliance locations. This analysis focuses on conditions in the southern Delta since salinity standards upstream are not changing. These results can then be qualitatively applied to the 1995–2015 baseline water quality; if there is an increase in EC compared to the model baseline, it is likely EC would increase compared to baseline water quality conditions as well, and there would be degradation.

As described in Appendix F.1, *Hydrologic and Water Quality Modeling*, the WSE model estimates of monthly EC are based on the Vernalis EC results extracted from a version of the CALSIM II SJR Module. Since EC is highly dependent on flow volume, the WSE model calculated EC at Vernalis is the CALSIM II estimate adjusted by the ratio of flow at Vernalis in CALSIM II compared to the WSE model. EC values predicted in the WSE model for Brandt Bridge, Old River near Middle River and Old River at Tracy Boulevard Bridge are based on the empirical relationship between flow conditions and the observed incremental increase in EC between Vernalis and these downstream locations. The relationship between flow and the incremental increase in EC was found to be the same for both the Brandt Bridge and Old River near Middle River compliance locations (see Appendix F.1 for more details). Consequently, the distribution of EC values predicted under the LSJR alternatives is the same for Brandt Bridge and Old River near Middle River.

CALSIM II EC values were used as a starting point for the WSE model because the CALSIM II results include a suitably long time period to account for long term variation in salinity (82-year period) and because CALSIM II closely matches recent historical salinity at Vernalis. Figure 23-4 compares the monthly average time series of observed EC data (from CDEC) at Vernalis with the CALSIM II estimates of EC at Vernalis from January 1995– September 2003. Figure 23-4 shows that CALSIM II calculated EC is very similar to the historical EC from 1995–2003.

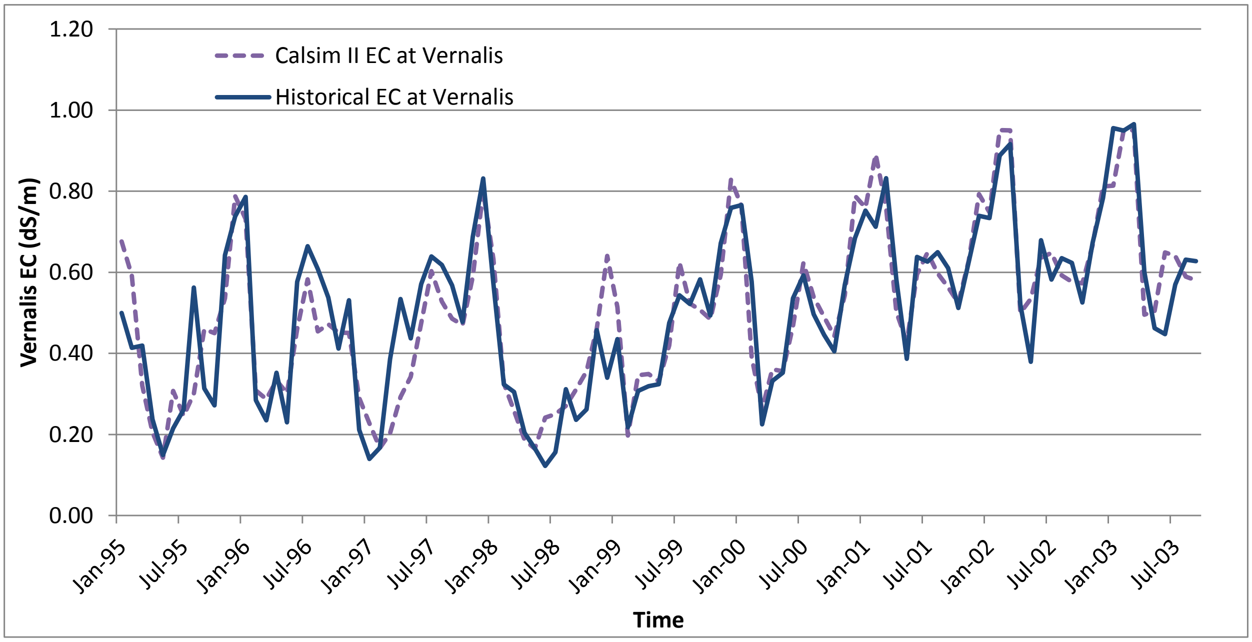

Figure 23-4. Monthly Average EC (dS/m = deciSiemens per meter) Observed at Vernalis Compared to CALSIM II Monthly Estimate of EC at Vernalis from 1995–2003

Effects of the Proposed LSJR Flow and SDWQ Objectives on Salinity

The EC results of the modeled LSJR alternatives are compared with the modeled baseline results for EC to assess whether a reduction in water quality is expected due to implementation of the proposed LSJR flow and EC water quality objectives. The modeled impacts on water quality can then be qualitatively applied to the baseline water quality, 1995–2015, to determine if there could be a degradation of water quality. The analysis shows that, overall, the baseline salinity in the southern Delta would not only be maintained under the proposed plan amendments, consistent with antidegradation requirements, but would generally improve during the irrigation season.

Table 23-2 presents the average annual EC values for each of the southern Delta compliance locations under the modeled baseline conditions and the change in those values for the LSJR flow objectives ranging from 20 to 60 percent unimpaired flow. Model results are provided for 30 and 50 percent unimpaired flow because adaptive implementation may, at times, result in a percentage of unimpaired flow that falls between proposed LSJR Alternatives 2, 3, and 4. As described above, the EC conditions as modeled in WSE are the same for the SJR at Brandt Bridge and for Old River near Middle River. All four stations experience an overall decrease in EC under each of the alternatives, with the least decrease under 20 percent unimpaired flow and the largest decrease under 60 percent unimpaired flow. The compliance location on Old River at Tracy Boulevard Bridge has the greatest reduction in EC for all alternatives but still has the highest modeled EC overall.

Table 23-2. Annual Average EC at Southern Delta Compliance Locations under Modeled Baseline Conditions and the Change in Value based on Percent of Unimpaired Flow

	Annual Average EC (dS/m)					
		Change from Baseline EC				
	Baseline	20% UF	30% UF	40% UF	50% UF	60% UF
SJR at Vernalis	0.57	-0.01	-0.02	-0.04	-0.06	-0.07
SJR at Brandt Bridge	0.61	-0.01	-0.02	-0.05	-0.06	-0.08
Old River near Middle River	0.61	-0.01	-0.02	-0.05	-0.06	-0.08
Old River at Tracy Boulevard Bridge	0.70	-0.01	-0.03	-0.06	-0.07	-0.09

EC (dS/m) = electrical conductivity (salinity) as measured in deciSiemens per meter
UF = unimpaired flow

Although there are individual months in some years when EC increases, in other months EC decreases much more substantially, particularly during the irrigation season. EC increases in the LSJR alternatives correspond to times when flow at Vernalis is lower than under modeled baseline. When the flow at Vernalis decreases it can usually be attributed to a change in the timing and magnitude of flood control releases (there are a few times when it is also caused by the elimination of VAMP and D1641 flow releases or by changes in the New Melones Index, which partially determines instream flow objectives on the Stanislaus River). The increases in EC merely represent shifts in salinity concentrations as water is moved from one period to another. Figures 23-5 through 23-7 show the exceedance plots for the change in monthly EC values under the LSJR flow objectives ranging from 20 to 60 percent unimpaired flow, relative to modeled baseline, at each of the southern Delta compliance locations. Depending on the alternative, about 10–20 percent of months show an increase in EC as water is moved around, while between 25 and 50 percent of months show a much more substantial decrease in EC. Overall, salinity concentrations would improve under the LSJR alternatives. Figures 23-8 through 23-10, discussed below, further illustrate the extent to which the predicted EC values under the LSJR alternatives would be substantially lower than the modeled baseline for the April–August irrigation season.

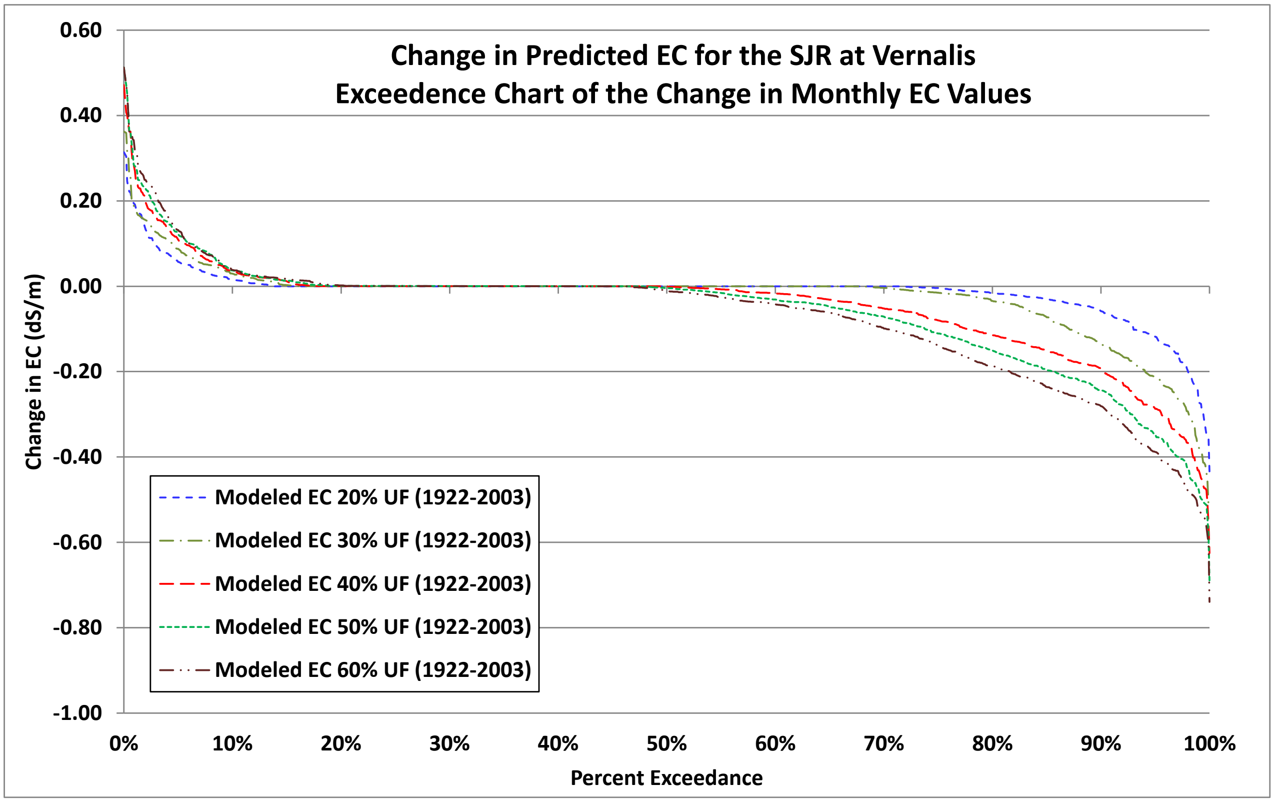

Figure 23-5. Exceedance Chart of the Change in Monthly EC Values for the SJR at Vernalis Based on Percent of Unimpaired Flow, Relative to Modeled Baseline

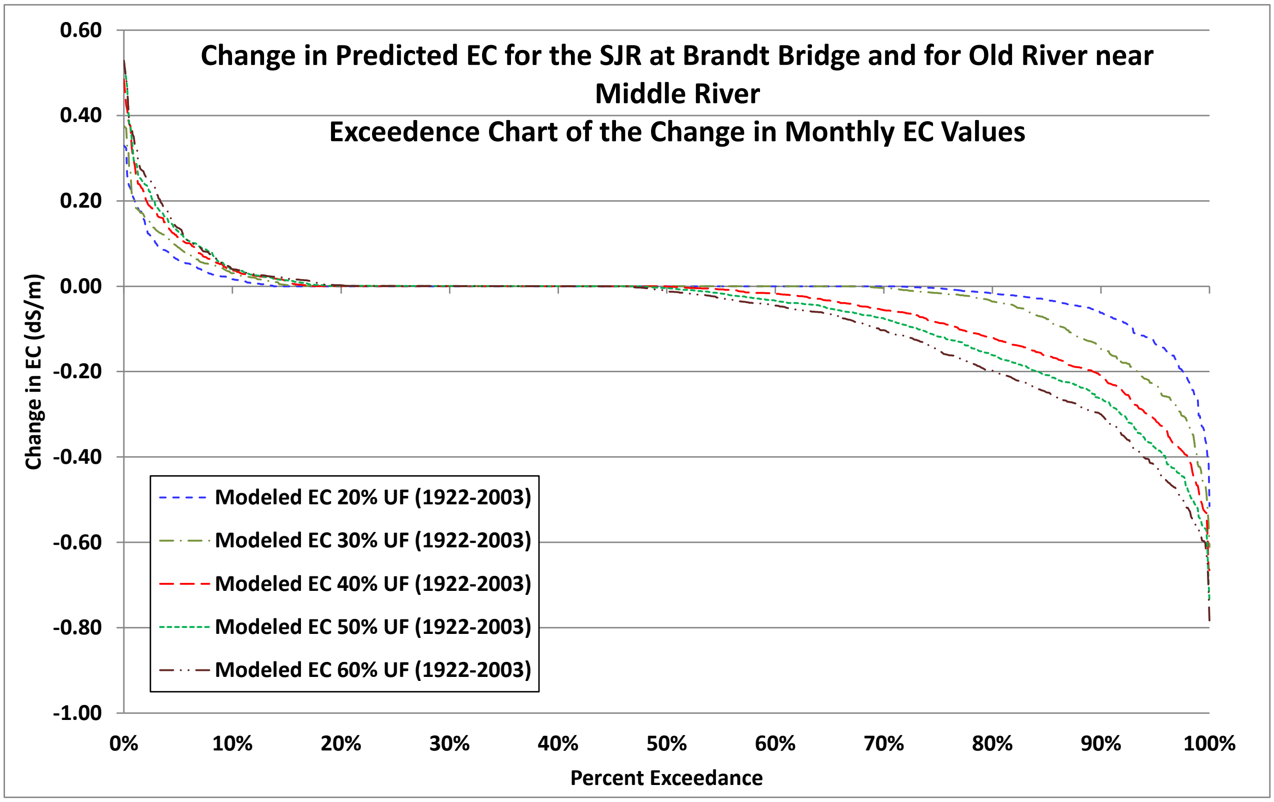

Figure 23-6. Exceedance Chart of the Change in Monthly EC Values, for the SJR at Brandt Bridge and for Old River near Middle River Based on Percent of Unimpaired Flow, Relative to Modeled Baseline

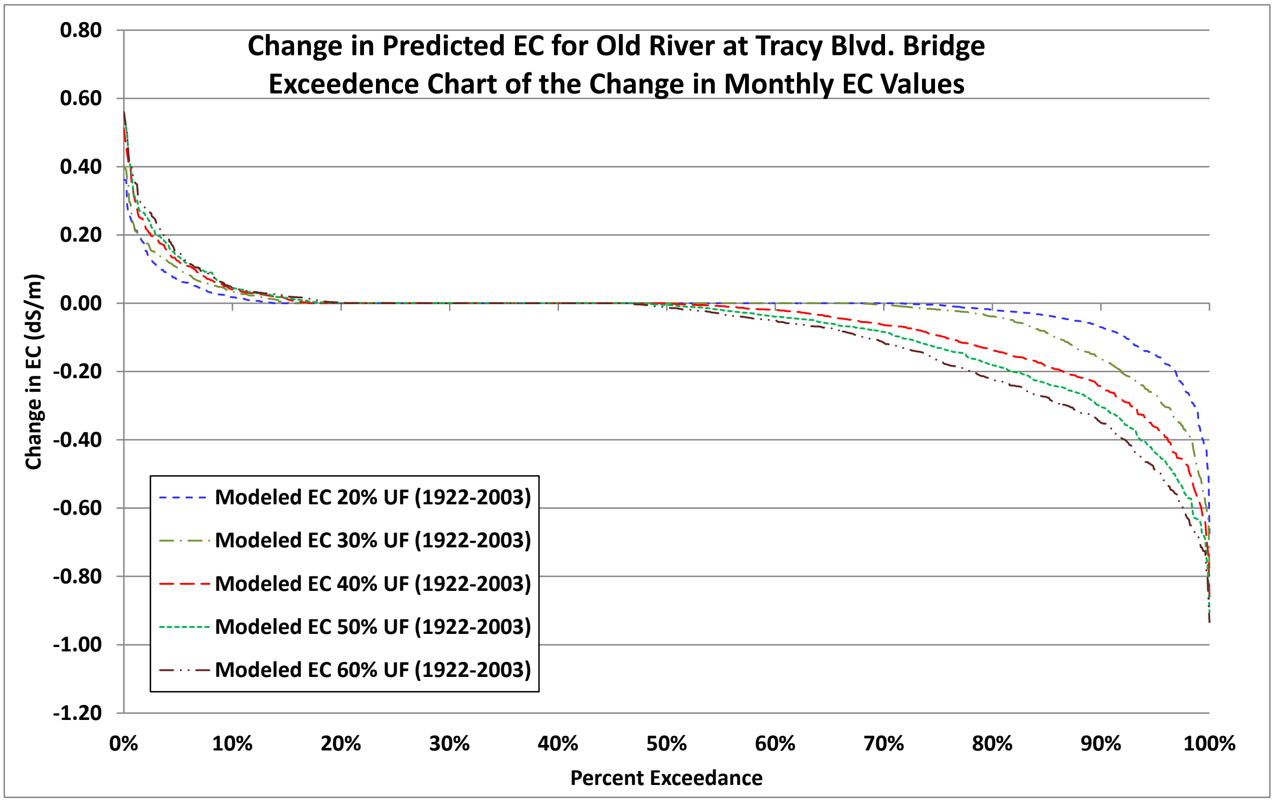

Figure 23-7. Exceedance Chart of the Change in Monthly EC Values for Old River at Tracy Boulevard Bridge Based on Percent of Unimpaired Flow, Relative to Modeled Baseline

Seasonal exceedance distributions are also analyzed to see if EC values might impair beneficial uses, particularly during the irrigation season. Figures 23-8 through 23-10 below compare the predicted average monthly EC results during the April – August irrigation season for each of the southern Delta compliance locations under the modeled baseline conditions and LSJR flow objectives ranging from 20 to 60 percent unimpaired flow. The LSJR alternatives would lead to lower EC values compared to baseline at all locations during the April – August period, with each subsequently higher unimpaired flow objective lowering the EC further.

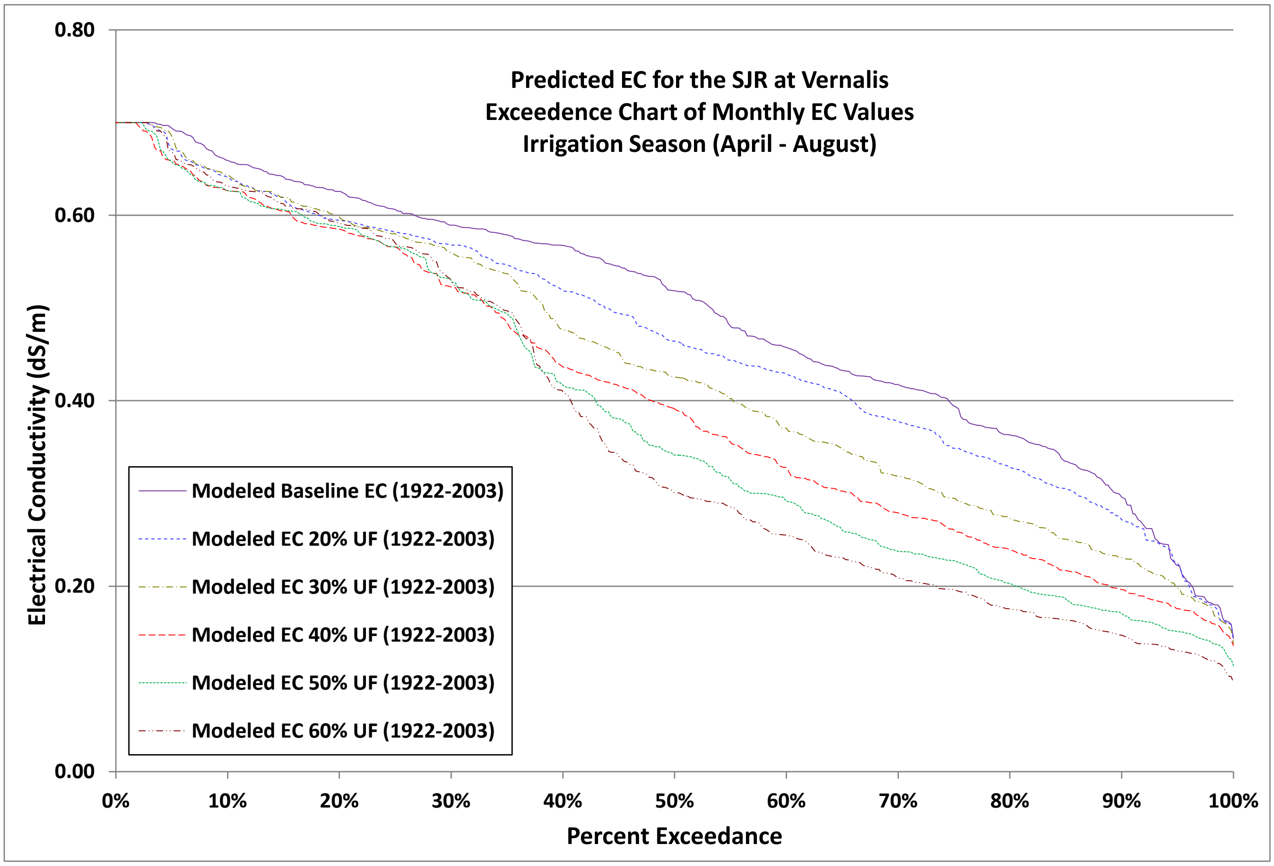

Figure 23-8. Exceedance Chart of Monthly EC Values at Vernalis during April–August under Modeled Baseline and Percent of Unimpaired Flow

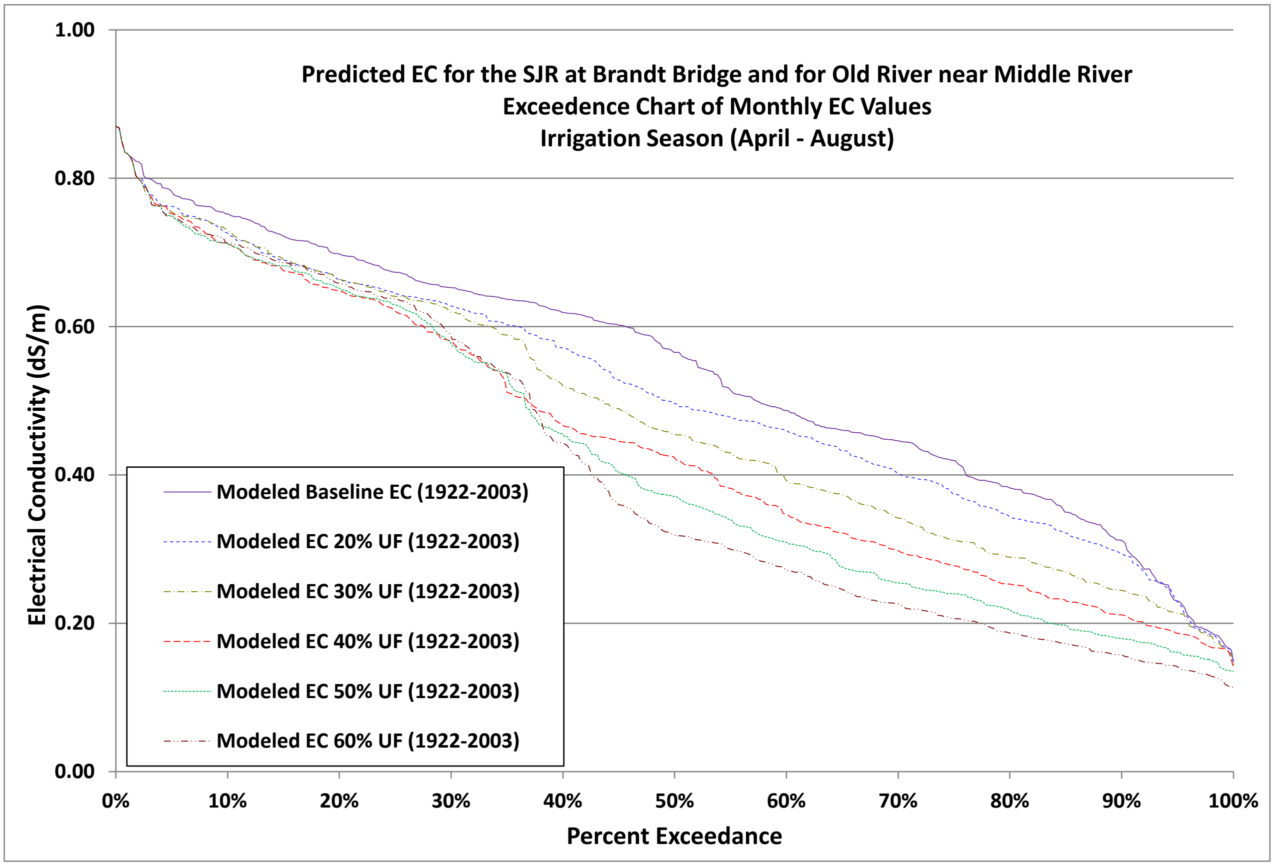

Figure 23-9. Exceedance Chart of Monthly EC Values for the SJR at Brandt Bridge and for Old River near Middle River during April–August under Modeled Baseline and Percent of Unimpaired Flow

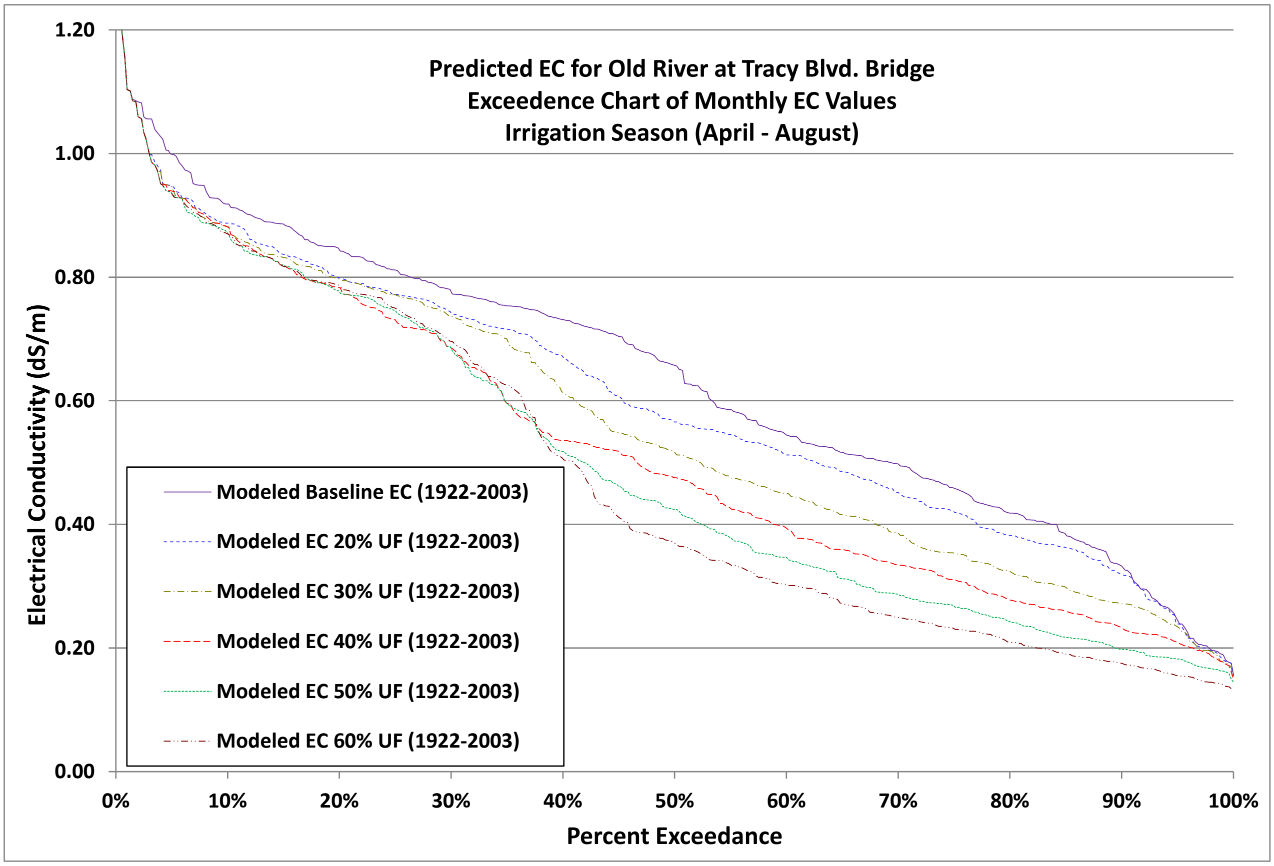

Figure 23-10. Exceedance Chart of Monthly EC Values for Old River at Tracy Boulevard Bridge during April–August under Modeled Baseline and Percent of Unimpaired Flow

Figures 23-11 through 23-13 compare the predicted average monthly EC results during the September–March non-irrigation season for each of the south Delta compliance locations under the modeled baseline conditions and LSJR flow objectives ranging from 20 to 60 percent unimpaired flow. The exceedance distribution of EC values does increase slightly over baseline conditions for some of the LSJR alternatives. These increases usually occur in the months of January and December when agricultural beneficial uses are not likely to be impacted. As described above, these occasional increases do not indicate a degradation of water quality, but rather only a shift in variable salinity as the timing and magnitude of flood control releases change.

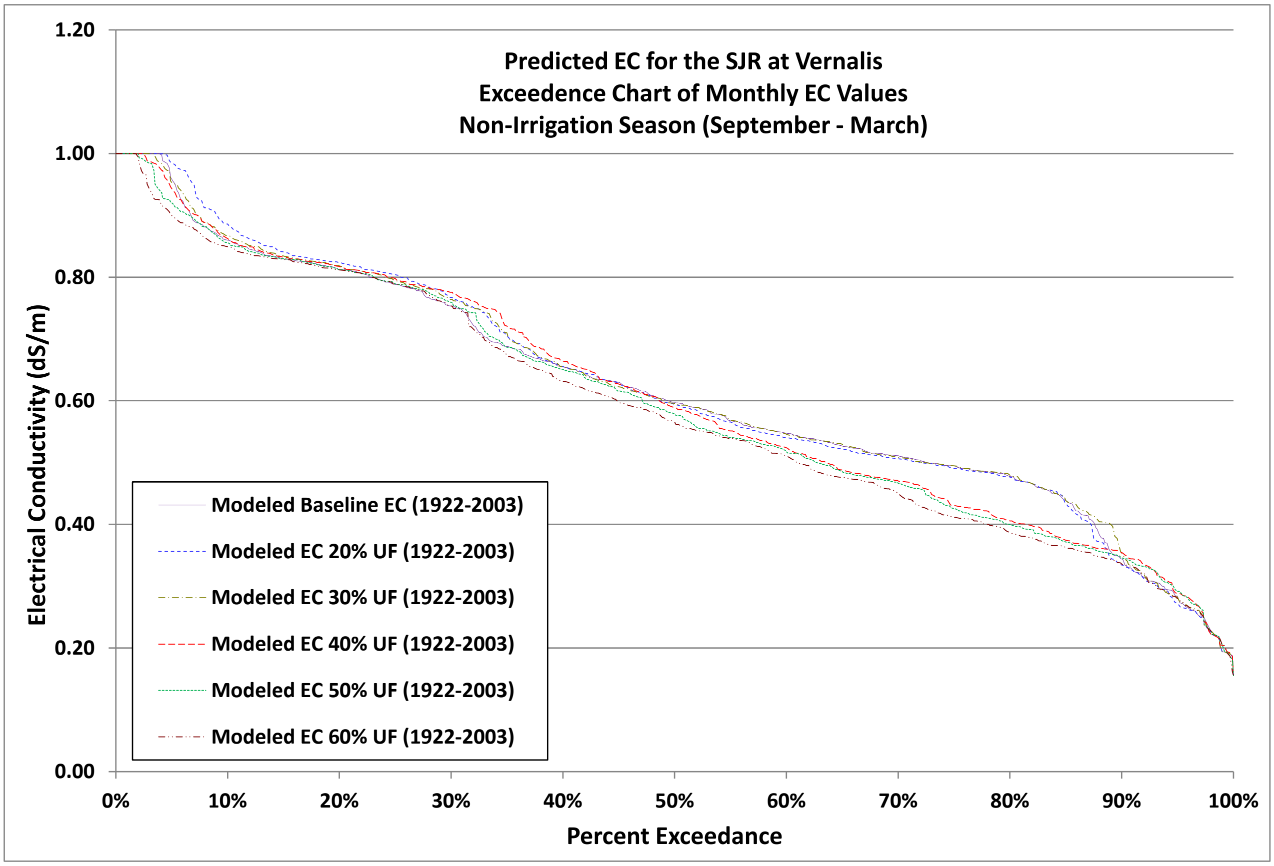

Figure 23-11. Exceedance Chart of Monthly EC Values at Vernalis during September–March under Modeled Baseline and Percent of Unimpaired Flow

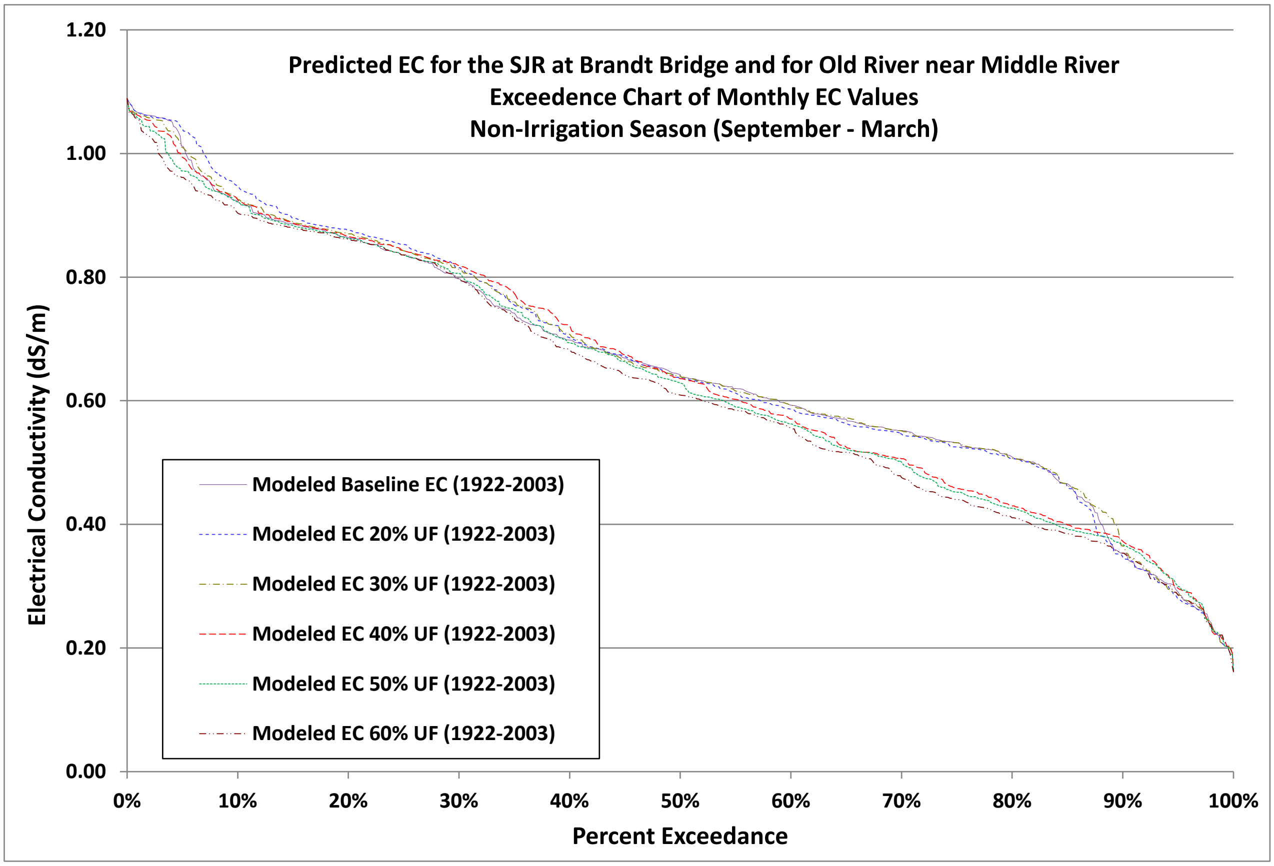

Figure 23-12. Exceedance Chart of Monthly EC Values for the SJR at Brandt Bridge and for Old River near Middle River during September–March under Modeled Baseline and Percent of Unimpaired Flow

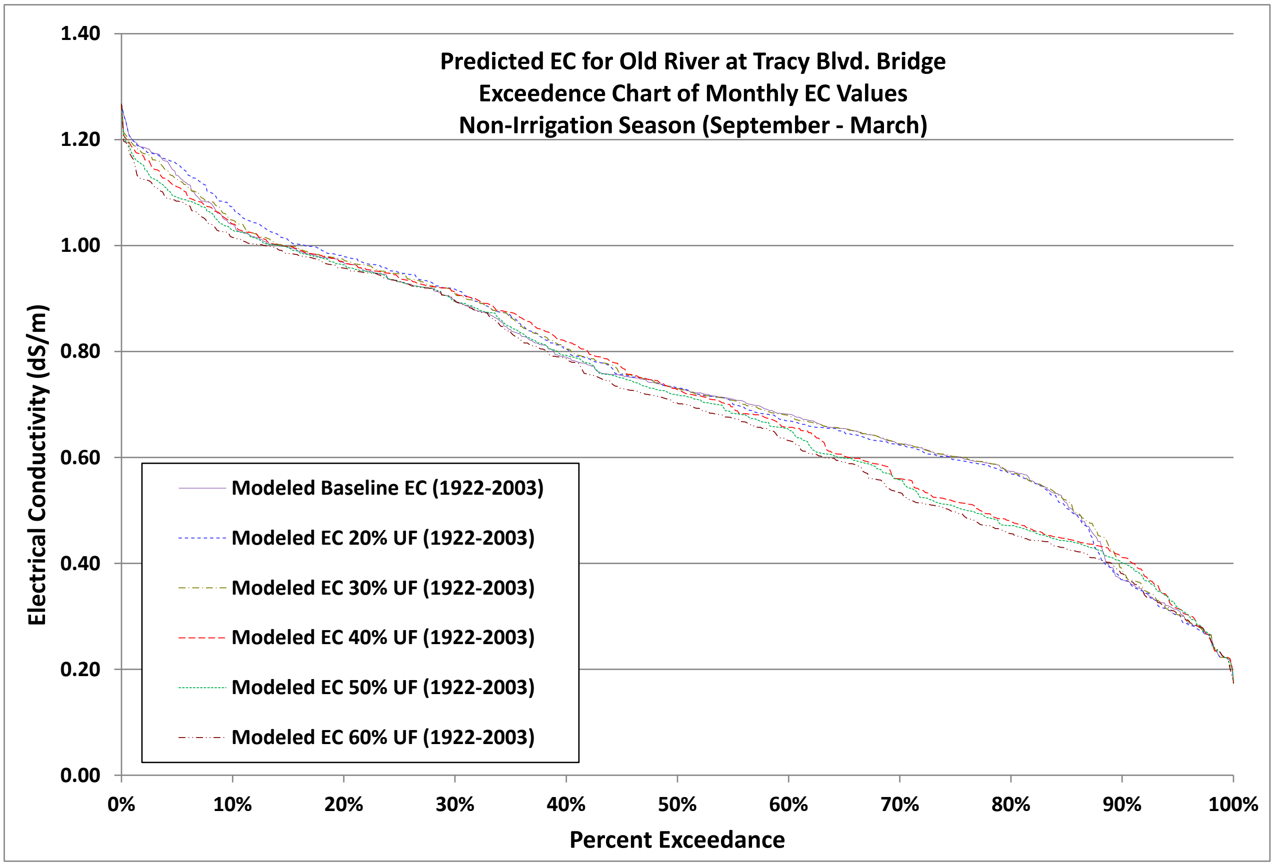

Figure 23-13. Exceedance Chart of Monthly EC Values for Old River at Tracy Boulevard Bridge during September–March under Modeled Baseline and Percent of Unimpaired Flow

Qualitative Discussion

WSE model runs for 1922 to 2003 show that changed flow patterns under the LSJR alternatives would also change salinity conditions, resulting in an overall decrease in salinity, and thus improving water quality with regard to salinity. This 82-year WSE model time period does not fully overlay the 1995 to 2015 period used to represent the baseline period of highest water quality for the purpose of the antidegradation analysis. The 82-year record, however, does include a range of hydrologic conditions that adequately characterizes the shorter, 20-year, 1995–2015 period. As described in Chapter 21, *Drought Evaluation*, WSE model simulations were used to compare drought impacts on water supply over the 1922–2003 analysis period with drought impacts during the more recent period of 2004–2015. The drought analysis showed, among other things, that runoff and water supply effects from 2004–2015 are not more extreme than drought conditions during the 1922–2003 period. Delta EC estimates are likely to be elevated during droughts because there is less water available to dilute salinity concentrations. The drought analysis, therefore, confirms that the modeled hydrologic conditions from 1922–2003 can be used to determine the overall and worst case salinity effects, with regard to antidegradation, for the 1995–2015 period.

The potential effect of the LSJR alternatives during the 1995–2015 period, with regard to antidegradation, would be to change the timing and magnitude of flows in the Stanislaus, Tuolumne, and Merced Rivers, and in the LSJR downstream of the Merced River confluence. Most of the SJR salt load originates upstream of the Merced River where high salinity agricultural discharges enter the Upper SJR and since the eastside tributaries have relatively low salinity the salt loads on the SJR would not change considerably. With increased flows, and unchanged salt loading, salt concentration would be diluted and EC would decrease. Conversely, with decreased flows and unchanged salt loading, salt concentrations would increase. From February–June, implementation of the proposed LSJR alternatives would generally increase flows, and would, therefore, decrease salinity concentrations. At other times of year, from July–January, EC would be the same as historical conditions during most years, except when flood control releases changed. Overall, salinity conditions would improve or be maintained in most years and annual average EC values would decrease, similar to the results presented in Table 23-2.

In addition, the proposed southern Delta salinity objectives would have no effect on salinity because USBR would still be required to meet a 0.7 dS/m EC objective at Vernalis from April–August as part of its water rights permits under the program of implementation. The September–March 1.0 dS/m EC objective would not change. Therefore, the responsibilities of USBR would not have changed from those in the period of 1995–2015, and New Melones would have been operated in the same way to protect EC conditions at Vernalis. This will assure that assimilative capacity is maintained downstream of Vernalis to meet the 1.0 dS/m EC water quality objective at the three remaining compliance locations in the southern Delta. Based on the crops grown in the southern Delta, an EC value of 1.0 dS/m would protect agricultural beneficial uses in the southern Delta (Appendix E, *Salt Tolerance of Crops in the Southern Sacramento–San Joaquin Delta*).

23.5.2 Flow

Antidegradation policies focus on water quality to protect beneficial uses. As part of the LSJR alternatives, flows from the eastside tributaries to the LSJR would increase during the February–June time period compared to the modeled baseline conditions. To the extent that antidegradation policies apply to water volume, increasing the flows is not expected to cause degradation in water quality. On the contrary, increasing the volume of flow would likely improve conditions for fish and wildlife beneficial uses throughout the LSJR Watershed. Annual flow contributions from the tributaries to the SJR are expected to increase by 3 percent under LSJR Alternative 2, 15 percent under LSJR Alternative 3, and 37 percent under LSJR Alternative 4. Adaptive implementation allows some shifting of flows both within and outside the February–June time frame to improve conditions for the protection of fish and wildlife beneficial uses and to preserve coldwater pool resources in the reservoirs. Though there may be instances when flows are lower than under modeled baseline, this would generally occur in wetter years during already high flows due to reduced need for flood control releases.

23.5.3 Other Parameters

This section evaluates whether changes in the LSJR flow objectives, together with the adaptive implementation measures described in Appendix K, *Revised Water Quality Control Plan*, would lower water quality for other parameters, like temperature and Clean Water Act (CWA) Section 303(d)[12] listed pollutants. This section serves as a simplified antidegradation analysis; based on best

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[12] Clean Water Act section 303(d) requires states, territories, and authorized tribes to develop a ranked list of water quality limited segments of rivers that do not meet water quality standards.

professional judgment, the proposed alternatives would not be adverse to the intent and purpose of the antidegradation policies (State Water Board 1990). This section employs the analyses and conclusions from elsewhere in this SED to explain why there will not be a lowering of water quality with respect to these other parameters. Chapter 5, *Surface Hydrology and Water Quality*, of this SED examines how the LSJR alternatives could impact water quality, including a discussion of impacts on water temperature and CWA Section 303(d) pollutants. Chapter 5 also investigates the potential water quality impacts of adaptive implementation for the LSJR alternatives by analyzing 30 and 50 percent of unimpaired flow.

Effects of the LSJR alternatives for pollutant concentrations are examined qualitatively based on flow changes in the LSJR and eastside tributaries predicted by the WSE model. Table 5-4 of Chapter 5 provides a list of current CWA Section 303(d) water quality impairments identified in the vicinity of the plan area. As described in more detail below, flow objectives ranging from 20 to 60 percent unimpaired flow on the eastside tributaries are not expected to lower water quality with respect to temperature or CWA Section 303(d) listed pollutants and they are expected to maintain or improve water quality for protection of beneficial uses.

The eastside tributaries are generally considered to be high quality waters. However, the tributaries still face impairment from several different pollutants. Agricultural activity in the lower segments of the Stanislaus, Tuolumne, and Merced Rivers is likely responsible for impairments due to pesticides (303[d] listed since 1998, 2002 and 1996, respectively), while mining activity has likely caused impairments due to mercury (listed since 2002, 2010 and 2006, respectively). All three tributaries were identified as impaired due to water temperature in 2010. The Merced River was identified as impaired due to E. coli in 2010 as well. Additionally, all three tributaries were listed as impaired due to unknown toxicity in 1998 for the Stanislaus River, 2006 for the Tuolumne River, and 2010 for the Merced River. The mainstem of the LSJR between Vernalis and the Merced River is also identified as impaired for a variety of water quality constituents. Segments of the LSJR are listed as impaired for mercury (beginning in 2006), unknown toxicity (beginning in 1994), and for various pesticides (beginning in 1994). The LSJR was first identified as impaired due to water temperature in the 2010 303(d) list. In addition, the small section of the LSJR between the Stanislaus River and Vernalis was also listed as impaired for E.coli in 2010.

In general, adding more streamflow can help dilute many of the above constituents that impair water quality in the LSJR and the tributaries. Inflows to the LSJR from the Stanislaus, Tuolumne, and Merced Rivers, which are characterized by low EC values, help dilute the salt loads entering the SJR from upstream, improving EC values between the Merced River and Vernalis. Elevated water temperature in the LSJR and in the tributaries is also influenced by streamflow, as a larger volume of water will take longer to warm.

In addition to concerns related to salinity, portions of the southern Delta are listed as impaired on the current CWA Section 303(d) list for a variety of constituents, including pesticides (first listed in 1992), and mercury (first listed in 1992). Old River and Middle River were both identified as impaired due to low dissolved oxygen in 2002. As noted in Chapter 5, Table 5-4 of the SED, the entire Delta is identified as impaired due to unknown toxicity. Aquatic toxicity causes mortality or severe negative sublethal effects (e.g., significant impacts on growth, reproductive success) for aquatic organisms. In the case of unknown toxicity, one or more constituents are causing the toxic effects, but they have not been identified.

Water Temperature

Chapter 5, *Surface Hydrology and Water Quality*, and Appendix F.1, *Hydrologic and Water Quality Modeling*, describe the analysis of water temperature impacts resulting from the LSJR alternatives. For this analysis, monthly streamflow results from the WSE model are entered into the HEC-5Q water quality model, developed for the SJR Watershed, to produce daily temperature results for the eastside tributaries and the LSJR. For the impact analysis, the water temperature modeling covers the time period from 197–2003. The average monthly streamflow temperatures for the modeled baseline conditions are compared with the same results for the LSJR alternatives.

As described in Chapter 5 and shown in Tables 5-23a, 5-23b, and 5-23c, the biggest reduction in water temperature is expected to occur during the April–June time period when higher flows are required under the LSJR alternatives. Generally, greater water temperature improvements are expected on the Tuolumne and Merced Rivers than on the Stanislaus River. For the SJR at Vernalis, modeling results indicate either slight improvement or no change in water temperature compared to the modeled baseline conditions. The program of implementation contained in Appendix K, *Revised Water Quality Control Plan*, allows for some flexibility in managing flows outside of the February–June time period. This flow shifting approach was incorporated into the WSE and water temperature modeling, which is why the water temperature model results (shown in Chapter 5, Tables 5-23a-c) show changes outside of the February–June period. Flow shifting may occur under any of the LSJR alternatives above 30 percent unimpaired flow. Water temperatures can also be affected by changes in reservoir storage, which could occur during any month. For a more detailed description of flow shifting and how it is implemented in the WSE model, see Appendix F.1.

Additionally, Chapter 7, *Aquatic Biological Resources*, includes analysis and discussion of how the water temperature modeling results under the LSJR alternatives might affect fisheries resources and why colder streamflow temperatures are more beneficial for them. In general, implementation of the LSJR alternatives would improve streamflow temperatures for developing Chinook salmon and steelhead in the three eastside tributaries. Higher flows and cooler water temperatures in the tributaries are also expected to reduce predation impacts, improve growth opportunities, and reduce temperature-related stress in juvenile Chinook salmon and steelhead.

Clean Water Act Section 303(d) Listed Pollutants

The concentrations of CWA Section 303(d) listed pollutants in the LSJR and the eastside tributaries are more likely to approach or exceed water quality criteria levels when streamflow is low. An increase in flows, which is expected to occur under the proposed LSJR alternatives, would likely dilute pollutant concentrations and, since water quality in the eastside tributaries is generally good, improve water quality overall. The impact assessment for CWA Section 303(d) contaminants in Chapter 5, *Surface Hydrology and Water Quality*, of this SED is more of a qualitative analysis that relates changes in pollutant concentrations to changes in streamflow. The analysis examines changes in the monthly cumulative distributions of flows between modeled baseline and the LSJR alternatives for each tributary and the LSJR.

As described in Chapter 5, water quality is generally poorest under low flow conditions; therefore, changes in the cumulative flow distribution at the low end of the distribution are most likely to affect water quality. The analysis in Chapter 5 concludes that pollutant concentrations are not expected to exceed water quality criteria levels as a result of implementation of the LSJR alternatives. Instead, pollutant concentrations would likely be reduced due to increased dilution from the higher flows associated with the LSJR alternatives. There is potential for flows to decrease compared to the model baseline in wetter periods, as implementation of the LSJR alternatives may result in lower reservoir storage levels and smaller flood control releases. However, higher pollutant concentrations due to lower flows are not likely to occur because adaptive implementation would minimize the frequency of reduced flows. Certain adaptive implementation measures in Appendix K, *Revised Water Quality Control Plan*, would allow some of the February–June flow objective to be retained in storage and released later in the year to maintain or improve current temperature conditions. Therefore, water quality, as indicated by pollutant concentrations in the LSJR and the tributaries, is expected to improve under all LSJR alternatives.

23.6 Conclusion

Water quality conditions in the LSJR Watershed and southern Delta vary both seasonally and annually and are strongly affected by streamflow levels, due to dilution of the salt loads and other constituents in the affected areas. The LSJR and SDWQ alternatives, as well as their implementation, are not expected to reduce water quality; rather, water quality will be maintained and generally improved. More specifically, the proposed southern Delta salinity objective and program of implementation would not lead to a degradation of water quality, with regard to salinity, and would reduce the frequency of exceedance for the EC water quality objective at the interior southern Delta compliance locations. Moreover, USBR's water rights would continue to be conditioned on meeting the 0.7 dS/m EC standard at Vernalis during the irrigation season (April–August); therefore, water quality, with regard to salinity, is not expected to be lowered due to implementation of the proposed amendments to the 2006 Bay-Delta Plan. Modeling results for streamflow used to assess changes in 303(d) contaminant concentrations indicate that they are not expected to increase as a result of the proposed LSJR alternatives either, since baseline flows will either increase or stay the same through adaptive implementation. Water temperatures are expected to improve in the tributaries as well, and to a lesser extent in the SJR at Vernalis, especially during the February–June time period, as higher flows will buffer streamflow temperatures against warmer air temperatures. Since water quality will not be lowered, findings for degradation are not required under state and federal antidegradation policies.

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Chapter 24
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24.4 Other Agencies and Members of the Public

Through development of the updates to the 2006 *Bay-Delta Water Quality Control Plan* and the SED, the State Water Board has consulted with various agencies and members of the public. The following list includes those that were consulted to develop the draft SED.

- The Bay Institute
- California Department of Fish and Wildlife
- California Department of Transportation (CalTrans)
- California Department of Water Resources
- California Sportfishing Protection Alliance
- Central Delta Water Agency
- Central San Joaquin Irrigation District
- Central Valley Clean Water Association
- Central Valley Salinity Coalition
- Chowchilla Water District
- City of Tracy
- Contra Costa County Department of Conservation and Development
- Contra Costa Water District
- County of San Joaquin
- Delta Stewardship Council
- Friant Water Authority
- Merced Irrigation District
- Modesto Irrigation District
- National Marine Fisheries Service
- Natural Resource Defense Council

- Northern California Water Association
- Oakdale Water District
- San Francisco Public Utilities Commission
- San Joaquin County Flood Control and Water Conservation District
- San Joaquin River Exchange Contractors Water Authority
- San Joaquin River Group Authority
- San Joaquin Tributaries Association
- San Luis and Delta-Mendota Water Authority and Westlands Water District
- South Delta Water Agency
- South San Joaquin Irrigation District
- State Water Contractors
- Stockton East Water District
- Turlock Irrigation District
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